DECLARATION

In the matter of U.S. Patent
Application No.09/686,959
in the name of
SEIKO EPSON CORPORATION

I, the undersigned, Yumi HARABE, of 22-7, 3-chome, Kitazawa, Setagaya-ku, Tokyo, Japan, do hereby declare that I am the translator of the documents attached and certify that the following is a true translation to the best of my knowledge and belief.

Signature

Harabe

Yumi HARABE

Dated March 17, 2003

PATENT OFFICE JAPANESE GOVERMENT

This is to certify that the annexed is a true copy of the following application as filed with this office.

Date of Application: February 7, 2000

Application Number: Japanese Patent Application No.028498/2000

Applicant(s): SEIKO EPSON CORPORATION

September 22, 2000

Commissioner, Kouzo OIKAWA

Japanese Patent Office

Certificate No.2000-3078110

(Translation)

[Document's Name] Patent Application

[Case Number] J0076361

[Addressee] Commissioner, the Patent Office

[International Patent Classification] B41J 2/165

[Inventor]

Address: c/o Seiko Epson Corporation
3-5, Owa 3-chome, Suwa-shi,
Nagano-ken, 392-8502 JAPAN

Name: Toshiki Usui

[Applicant]

(Identification Number) 000002369

Name: Seiko Epson Corporation

[Agent]

(Identification Number) 100101236

(Patent Attorney)

(Name) Hiroyuki KURIHARA

[Claim of Priority based on previous application]

[Filing Number] No.1999-290165

[Filing Date] October 12, 1999

[Indication of Official fee]

[Account Number of Pre-payment] 042309

[Amount] ¥21,000.-

[List of the filing documents]

[Document Name] Specification 1 copy

[Document Name] Drawings 1 copy

[Document Name] Abstract 1 copy

[Number of General Power of Attorney] 9806571

[Necessity of Proof] Yes

[Name of Document] Specification

[Title of the Invention] INK-JET RECORDING APPARATUS AND RECORDING METHOD

[What is Claimed is]

[Claim 1] An ink-jet recording apparatus comprising a recording head that ejects ink from an ink reservoir portion and driving signal generating means that generates a driving signal for ejecting ink droplets, characterized in that ink reservation amount obtaining means for obtaining an ink reservation amount of the ink reservoir portion, temperature obtaining means for obtaining an temperature change amount of the recording head, and driving signal correcting means for correcting the driving signal generated from the driving signal generating means based on the temperature change amount of the recording head obtained by this temperature obtaining means and the ink reservation amount obtained by the ink reservation amount obtaining means are provided.

[Claim 2] The ink-jet recording apparatus according to claim 1, characterized in that said temperature obtaining means includes temperature detecting means for detecting a temperature of the recording head and temperature information storing means for storing head temperature information from this temperature detecting means.

[Claim 3] The ink-jet recording apparatus according to claim 2, characterized in that said temperature information storing means stores the head temperature information since the time a power source is turned on.

[Claim 4] The ink-jet recording apparatus according to claim 2 or 3, characterized in that said temperature information storing means stores the head temperature information in a standby state of an recording operation.

[Claim 5] The ink-jet recording apparatus according to any one of claim 2 to claim 4, characterized in that said temperature information storing means keeps the stored head temperature information even after the power source was turned off.

[Claim 6] The ink-jet recording apparatus according to claim 5, characterized in that said temperature obtaining means obtains the temperature change amount by using the head temperature information kept in the temperature information storing means when the power source is turned on again within a specified period of time after the power source was turned off.

[Claim 7] The ink-jet recording apparatus according to any one of claim 1 to claim 6, characterized in that said driving signal generating means generates the driving signal including a driving pulse capable of ejecting ink droplets, and the driving signal correcting means sets up a driving voltage of the driving pulse based on the temperature change amount and the ink reservation amount.

[Claim 8] The ink-jet recording apparatus according to any one of claim 1 to claim 7, characterized in that said driving signal generating means generates the driving signal including the driving pulse capable of ejecting ink droplets, and the driving signal correcting means changes a waveform of the driving pulse based on the temperature change amount and the ink reservation

amount.

[Claim 9] The ink-jet recording apparatus according to any one of claim 1 to claim 8, characterized in that the recording head performs a preparatory ejection operation by using the driving signal generated by said driving signal generating means, and this driving signal for the preparatory ejection operation is also corrected by said driving signal correcting means.

[Claim 10] An ink-jet recording apparatus comprising a recording head for ejecting ink from an ink reservoir portion and driving signal generating means for generating a driving signal to eject ink droplets, characterized in that temperature obtaining means for obtaining a temperature change amount of the recording head, ink reservation amount obtaining means for obtaining an ink reservation amount of the ink reservoir portion, and changing means for changing control of a preparatory ejection operation based on the temperature change amount of the recording head obtained by said temperature obtaining means and the ink reservation amount obtained by said ink reservation amount obtaining means are provided.

[Claim 11] The ink-jet recording apparatus according to claim 10, characterized in that said changing means changes a driving voltage and driving time that form an ejection waveform in the preparatory ejection operation.

[Claim 12] The ink-jet recording apparatus according to any one of claim 10 and claim 11, characterized in that said changing means changes a number of times of ejection in one preparatory ejection operation.

[Claim 13] The ink-jet recording apparatus according to any one of claim 10 to claim 12, characterized in that said changing means changes an interval of said preparatory ejection operation.

[Claim 14] The ink-jet recording apparatus according to any one of claim 10 to claim 13, characterized in that said changing means changes a cycle of ejection in said preparatory ejection operation.

[Claim 15] The ink-jet recording apparatus according to any one of claim 10 to claim 14, characterized in that said temperature obtaining means includes temperature detecting means for detecting a temperature of the recording head and temperature information storing means for storing head temperature information from this temperature detecting means.

[Claim 16] The ink-jet recording apparatus according to claim 15, characterized in that said temperature information storing means is allowed to store the head temperature information since the time a power source is turned on.

[Claim 17] The ink-jet recording apparatus according to any one of claim 15 to 16, characterized in that said temperature information storing means is allowed to store the head temperature information in a standby state of an recording operation.

[Claim 18] The ink-jet recording apparatus according to any one of claim 15 to claim 17, characterized in that said temperature information storing means keeps the stored head temperature information even after the power source was turned off.

[Claim 19] The ink-jet recording apparatus according to claim

18, characterized in that said temperature obtaining means obtains the temperature change amount by using the head temperature information kept in the temperature information storing means when the power source is turned on again within a specified period of time after the power source was turned off.

[Claim 20] An ink-jet recording method that performs printing by use of a recording head that ejects ink from an ink reservoir portion, characterized by comprising the steps of obtaining an ink reservation amount in the ink reservoir portion as well as obtaining a temperature change amount of said recording head, and correcting a driving signal based on the temperature change amount of said recording head and said ink reservation amount.

[Claim 21] The ink-jet recording method according to claim 20, characterized in that said step of obtaining the temperature change amount of the recording head includes the steps of detecting the temperature of said recording head, and storing head temperature information which is detected.

[Claim 22] The ink-jet recording method according to claim 21, characterized in that said head temperature information since the time a power source is turned on is stored in said step of storing the head temperature information.

[Claim 23] The ink-jet recording method according to any one of claim 21 and claim 22, characterized in that said head temperature information in a standby state of a recording operation is stored in said step of storing the head temperature information.

[Claim 24] The ink-jet recording method according to any one of claim 21 to claim 23, characterized in that said head temperature information stored in said step of storing the head temperature information is kept even after the power source was turned off.

[Claim 25] The ink-jet recording method according to claim 24, characterized in that the temperature change amount is obtained by using said head temperature information stored when the power source is turned on again within a specified period of time after the power source was turned off in said step of obtaining the temperature change amount of the recording head.

[Claim 26] The ink-jet recording method according to any one of claim 20 to claim 25, characterized in that a driving voltage of a driving pulse capable of ejecting ink droplets and included in the driving signal is set up in said step of correcting the driving signal.

[Claim 27] The ink-jet recording method according to any one of claim 20 to claim 26, characterized in that a waveform of the driving pulse capable of ejecting ink droplets included in the driving signal is also changed in said step of correcting the driving signal.

[Claim 28] The ink-jet recording method according to any one of claim 20 to claim 27, characterized in that the driving signal for allowing said recording head to perform a preparatory ejection operation is also corrected in said step of correcting the driving signal.

[Claim 29] An ink-jet recording method that performs printing

by use of a recording head that ejects ink from an ink reservoir portion, characterized by comprising the steps of obtaining an ink reservation amount in the ink reservoir portion as well as obtaining a temperature change amount of the recording head, and changing control of a preparatory ejection operation based on the temperature change amount of the recording head and the ink reservation amount.

[Claims 30] The ink-jet recording method according to claim 29, characterized in that a driving voltage and driving time which form an ejection waveform in the preparatory ejection operation are changed in said step of changing control of the preparatory ejection operation.

[Claims 31] The ink-jet recording method according to any one of claim 29 and claim 30, characterized in that a number of times of ejection in the preparatory ejection operation is changed in said step of changing control of the preparatory ejection operation.

[Claim 32] The ink-jet recording method according to any one of claim 29 to claim 31, characterized in that an interval of the preparatory ejection operation is changed in said step of changing control of the preparatory ejection operation.

[Claim 33] The ink-jet recording method according to any one of claim 29 to claim 32, characterized in that a cycle of ejection in the preparatory ejection operation is changed in said step of changing control of the preparatory ejection operation.

[Claim 34] The ink-jet recording method according to any one of claim 29 to claim 33, characterized in that said step of

obtaining the temperature change amount of the recording head includes the steps of detecting the temperature of said recording head, and storing head temperature information which is detected.

[Claim 35] The ink-jet recording method according to claim 34, characterized in that said head temperature information since the time a power source is turned on is stored in said step of storing the head temperature information.

[Claim 36] The ink-jet recording method according to any one of claim 34 and claim 35, characterized in that said head temperature information in a standby state of a recording operation is stored in said step of storing the head temperature information.

[Claim 37] The ink-jet recording method according to any one of claim 34 to claim 36, characterized in that said head temperature information stored in said step of storing the head temperature information is kept even after the power source was turned off.

[Claim 38] The ink-jet recording method according to claim 37, characterized in that the temperature change amount is obtained by using said head temperature information stored when the power source is turned on again within a specified period of time after the power source was turned off in said step of obtaining the temperature change amount of the recording head.

[Claim 39] A recording medium that stores a program for correcting a driving signal of an ink-jet recording apparatus that performs printing by use of a recording head for ejecting ink from an ink reservoir portion, characterized in that said program is

rendered to obtain an ink reservation amount of said ink reservoir portion as well as to obtain a temperature change amount of said recording head, and is rendered to correct the driving signal based on the temperature change amount of said recording head and said ink reservation amount.

[Claim 40] A recording medium that stores a program for correcting a driving signal of an ink-jet recording apparatus that performs printing by use of a recording head for ejecting ink from an ink reservoir portion, characterized in that an ink reservation amount of the ink reservoir portion is obtained as well as a temperature change amount of the recording head is obtained, and control of a preparatory ejection operation is changed based on the temperature change amount of the recording head and the ink reservation amount.

[Detailed Description of the Invention]

[0001]

[The technical field to which the Invention Belongs]

The present invention relates to an ink-jet recording apparatus that ejects ink reserved in an ink reservoir portion such as an ink cartridge and an ink tank from a recording head, and a recording method.

[0002]

[Prior Art]

An ink-jet recording apparatus such as an ink-jet printer and an ink-jet plotter (hereinafter referred to as a recording apparatus) comprises a recording head that is capable of ejecting

ink as ink droplets, which is reserved in an ink reservoir portion such as an ink cartridge and an ink tank. And, in this recording apparatus, the recording head is made to move along a main scanning direction, and ink droplets are ejected from the recording head so as to interlock with the movement of the recording head.
[0003]

Incidentally, if an environmental temperature (for example, a room temperature) at a place where the recording apparatus is used is changed, the ejection amount of ink droplets fluctuates since ink viscosity is changed. For example, when the environmental temperature is higher than a base temperature in a design, the ink viscosity becomes lower than a normal state. Thus, when the ink droplets are ejected in a standard driving pulse, the amount of ejected ink droplets becomes larger than a designed value. Conversely, when the environmental temperature is lower than the base temperature, the ink viscosity becomes higher than a normal state. Thus, when the ink droplets are ejected in a standard driving pulse, the amount of ejected ink droplets becomes smaller than the designed value. Such fluctuation of the ink amount is a cause of deterioration of image quality.
[0004]

Accordingly, in order to prevent the ink amount from fluctuating along with changes of environmental temperatures, a recording apparatus is provided, in which a temperature sensor such as a thermistor is provided, for example, on a recording head or a carriage, and the driving signal that drives the

piezoelectric element based on head temperature information detected by the temperature sensor is adjusted.

[0005]

In this recording apparatus, for example, when the head temperature information is lower than the base temperature, a driving voltage for a driving pulse included in the driving signal is set higher than the standard value. On the contrary, when the head temperature information is higher than the base temperature, the driving voltage for the driving pulse is set lower than the standard value.

[0006]

[Problem to be solved by the Invention]

However, since the head temperature information used for correcting the driving signal is an environmental temperature such as a room temperature, a difference from a temperature of ink reserved in an ink reservoir portion may occur in some cases. This is because the heat capacity of ink is greater than the heat capacity of air, and because ink has a property that it is harder to heat and harder to cool down. And, when a difference exists between the head temperature information and the ink temperature, it is difficult to uniform ink droplets into a desired amount even if the driving signal is corrected based on the head temperature information.

[0007]

And, such a phenomenon appears prominently when a sudden temperature change occurs in a place of use, such as on an occasion that air conditioning is turned on in summer or heating is turned

on in winter.

[0008]

The present invention was invented in consideration of the foregoing problems, and a subject of the present invention is set to provide an ink-jet recording apparatus and a recording method, which can make an ejection amount of ink droplets of uniform quantity even if a temperature change occurs in a place where the recording apparatus is used, and can obtain a recorded image of stable quality.

[0009]

[Means for Solving the Problems]

A first aspect of the present invention for solving the foregoing subject is an ink-jet recording apparatus which includes a recording head for ejecting ink from an ink reservoir portion and driving signal generating means for generating a driving signal for ejecting ink droplets, and is characterized in that it comprises: ink reservation amount obtaining means for obtaining an ink reservation amount in the ink reservoir portion; temperature obtaining means for obtaining an amount of temperature change of the recording head; and driving signal correcting means for correcting a driving signal to be generated by the driving signal generating means based on the temperature change amount of the recording head obtained by this temperature obtaining means and the ink reservation amount obtained by the ink reservation amount obtaining means.

[0010]

In the first aspect, since the driving signal correcting

means can correct the driving signal so as to suit for an actual temperature of ink in accordance with the temperature change amount of the recording head and the ink reservation amount, the recording head can record images of a stable quality regardless of a change of an environmental temperature.

[0011]

A second aspect of the present invention is the ink-jet recording apparatus according to the first aspect, characterized in that said temperature obtaining means includes temperature detecting means for detecting the temperature of the recording head and temperature information storing means for storing head temperature information from the temperature detecting means.

[0012]

In the second aspect, the temperature change amount of the recording head can be obtained relatively easily by the temperature detecting means and the temperature information storing means.

[0013]

A third aspect of the present invention is the ink-jet recording apparatus according to the second aspect, characterized in that the head temperature information since the time a power source is turned on is made to be stored in said temperature information storing means.

[0014]

In the third aspect, since the head temperature information is stored since the time the power source is turned on, the temperature change amount of the recording head since the time

the power source is turned on can be obtained; moreover, the driving signal correcting means can perform correction suitable for an ink temperature based on the additional information.

[0015]

A fourth aspect of the present invention is the ink-jet recording apparatus according to any one of the second and third aspects, characterized in that the head temperature information in a standby state of an recording operation is made to be stored in said temperature information storing means.

[0016]

In the fourth aspect, since the head temperature information is stored even in a standby state, the driving signal correcting means can perform correction suitable for the ink temperature based on the additional information.

[0017]

A fifth aspect of the present invention is the ink-jet recording apparatus according to any one of the second to fourth aspects, characterized in that said temperature information storing means keeps the stored head temperature information even after the power source was turned off.

[0018]

In the fifth aspect, since the head temperature information is stored even after the power source was turned off, the driving signal correcting means can perform correction suitable for the ink temperature based on the additional information when the power source is turned on again.

[0019]

A sixth aspect of the present invention is the ink-jet recording apparatus according to the fifth aspect, characterized in that said temperature obtaining means obtains an amount of temperature change by using the head temperature information kept in the temperature information storing means when the power source is turned on again within a specified period of time after the power source was turned off.

[0020]

In the sixth aspect, when the power source is turned on within a specified period of time, the driving signal correcting means can perform correction suitable for the ink temperature by using the head temperature information before the power source was turned off.

[0021]

A seventh aspect of the present invention is the ink-jet recording apparatus according to any one of the first to sixth aspects, characterized in that said driving signal generating means generates a driving signal including a driving pulse which can eject ink droplets, and the driving signal correcting means sets up a driving voltage of the driving pulse based on the temperature change amount and the ink reservation amount.

[0022]

In the seventh aspect, the recording head can be driven with the driving voltage suitable for the ink temperature by the driving signal correcting means setting up the driving voltage.

[0023]

An eighth aspect of the present invention is the ink-jet recording apparatus according to any one of the first to seventh aspects characterized in that said driving signal generating means generates the driving signal including the driving pulse which can eject ink droplets, and the driving signal correcting means changes a waveform of the driving pulse based on the temperature change amount and the ink reservation amount.

[0024]

In the eighth aspect, the driving signal correcting means can drive the recording head with the waveform of the driving pulse suitable for the ink temperature by the driving signal correcting means changing the waveform of the driving pulse.

[0025]

A ninth aspect of the present invention is the ink-jet recording apparatus according to any one of the first to eighth aspects, characterized in that the recording head performs a preparatory ejection operation by using the driving signal which said driving signal generating means generates, and that the driving signal of this preparatory ejection operation is also corrected by said driving signal correcting means.

[0026]

In the ninth aspect, by performing the preparatory ejection operation with the driving signal corrected by the driving signal correcting means, plugging of a nozzle orifice is surely prevented and ejection of unnecessary ink due to the preparatory ejection is also suppressed.

[0027]

A tenth aspect of the present invention is an ink-jet recording apparatus including a recording head for ejecting ink from an ink reservoir portion and driving signal generating means for generating a driving signal to eject ink droplets, which comprises: temperature obtaining means for obtaining a temperature change amount of the recording head; ink reservation amount obtaining means for obtaining an ink reservation amount in the ink reservoir portion; and changing means for changing control of a preparatory ejection operation based on the temperature change amount of the recording head obtained by said temperature obtaining means and the ink reservation amount obtained by said ink reservation amount obtaining means.

[0028]

In the tenth aspect, since the control of the preparatory ejection operation is changed in accordance with an actual ink temperature, plugging of a nozzle orifice can be surely prevented.

[0029]

An eleventh aspect of the present invention is the ink-jet recording apparatus according to the tenth aspect, characterized in that said changing means changes a driving voltage and driving time that form an ejection waveform in the preparatory ejection operation.

[0030]

In the eleventh aspect, since the preparatory ejection waveform by the preparatory ejection operation suitable for an actual ink temperature is changed, ink is surely ejected and

ejection of unnecessary ink is suppressed.

[0031]

A twelfth aspect of the present invention is the ink-jet recording apparatus according to any one of the tenth and eleventh aspects, characterized in that said changing means changes the number of times of ejection in one preparatory ejection operation.

[0032]

In the twelfth aspect, the ink ejection amount in the preparatory ejection operation is adjusted, ink of increased viscosity is surely ejected and unnecessary ejection of ink is suppressed.

[0033]

A thirteenth aspect of the present invention is the ink-jet recording apparatus according to any one of the tenth to twelfth aspects, characterized in that said changing means changes an interval of said preparatory ejection operations.

[0034]

In the thirteenth aspect, since the frequency of the preparatory ejection operations is changed, ink of increased viscosity is surely ejected and unnecessary ejection of ink is suppressed.

[0035]

A fourteenth aspect of the present invention is the ink-jet recording apparatus according to any one of the tenth to thirteenth aspects, characterized in that said changing means changes an ejection cycle in said preparatory ejection operation.

[0036]

In the fourteenth aspect, an ink ejection amount by the preparatory ejection operation is adjusted and stability of ink ejection is improved, thus ink of increased viscosity is surely ejected and ejection of unnecessary ink is suppressed.

[0037]

A fifteenth aspect of the present invention is the ink-jet recording apparatus according to any one of the tenth to fourteenth aspects, characterized in that said temperature obtaining means includes: temperature detecting means for detecting a recording head temperature; and temperature information storing means for storing head temperature information from this temperature detecting means.

[0038]

In the fifteenth aspect, the temperature change amount of the recording head can be obtained relatively easily by the temperature detecting means and the temperature information storing means.

[0039]

A sixteenth aspect of the present invention is the ink-jet recording apparatus according to the fifteenth aspect, characterized in that the head temperature information since the time a power source is turned on is made to be stored in said temperature information storing means.

[0040]

In the sixteenth aspect, since the head temperature information is stored since the time the power source is turned

on, the temperature change amount of the recording head since the time the power source is turned on can be obtained and the changing means can perform correction suitable for the ink temperature based on the additional information.

[0041]

A seventeenth aspect of the present invention is the ink-jet recording apparatus according to any one of the fifteenth and sixteenth aspects, characterized in that the head temperature information in a standby state of a recording operation is made to be stored in said temperature information storing means.

[0042]

In the seventeenth aspect, since the head temperature information is stored even in the standby state, the changing means can perform correction suitable for the ink temperature based on the additional information.

[0043]

An eighteenth aspect of the present invention is the ink-jet recording apparatus according to any one of the fifteenth to seventeenth aspects, characterized in that said temperature information storing means still keeps the stored head temperature information after the power source was turned off.

[0044]

In the eighteenth aspect, since the head temperature information is still stored after the power source was turned off, the changing means can perform correction suitable for the ink temperature based on the additional information when the power source is turned on again.

[0045]

A nineteenth aspect of the present invention is the ink-jet recording apparatus according to the eighteenth aspect, characterized in that said temperature obtaining means obtains the temperature change amount using the head temperature information kept by the temperature information storing means, when the power source is turned on again within a specified period of time after the power source was turned off.

[0046]

In the nineteenth aspect, when the power source is turned on within a specified period of time, the changing means can perform correction suitable for the ink temperature by use of the head temperature information before the power source was turned off.

[0047]

A twentieth aspect of the present invention is an ink-jet recording method of performing printing by use of a recording head which ejects ink from an ink reservoir portion, which comprises the steps of: obtaining an ink reservation amount in the ink reservoir portion as well as obtaining a temperature change amount of said recording head; and correcting a driving signal based on the temperature change amount of said recording head and said ink reservation amount.

[0048]

In the twentieth aspect, since correction is performed on the driving signal to be suitable for an actual driving signal corresponding to the temperature change amount of the recording

head and the ink reservation amount, the recording head can record images of a stable quality regardless of a change of an environmental temperature.

[0049]

A twenty-first aspect of the present invention is the ink-jet recording method according to the twentieth aspect, characterized in that said step of obtaining the temperature change amount of the recording head includes the steps of: detecting said recording head temperature and storing this head temperature information which is detected.

[0050]

In the twenty-first aspect, since the recording head temperature is detected and head temperature information is stored, the temperature change amount of the recording head can be obtained relatively easily.

[0051]

A twenty-second aspect of the present invention is the ink-jet recording method according to the twenty-first aspect, characterized in that said head temperature information since the time a power source is turned on is stored in said step of storing the head temperature information.

[0052]

In the twenty-second aspect, since the head temperature information is stored since the time the power source is turned on, the temperature change amount of the recording head since the time the power source is turned on can be obtained and the correction of a driving signal suitable for an ink temperature

can be performed based on the additional head temperature information.

[0053]

A twenty-third aspect of the present invention is the ink-jet recording method according to any one of the twenty-first and twenty-second aspects, characterized in that said head temperature information in a standby state of a recording operation is stored in said step of storing the head temperature information.

[0054]

In the twenty-third aspect, since the head temperature information is stored even in the standby state, correction of the driving signal suitable for the ink temperature can be performed based on the additional head temperature information.

[0055]

A twenty-fourth aspect of the present invention is the ink-jet recording method according to any one of the twenty-first to twenty-third aspects, characterized in that said head temperature information stored in said step of storing head temperature information is still kept after the power source was turned off.

[0056]

In the twenty-fourth aspect, since the head temperature information is still kept after the power source was turned off, correction of the driving signal suitable for the ink temperature can be performed based on the additional information when the power source is turned on again.

[0057]

A twenty-fifth aspect of the present invention is the ink-jet recording method according to the twenty-fourth aspect, characterized in that, in said step of obtaining the temperature change amount of the recording head, the temperature change amount is obtained by use of said head temperature information stored when the power source is turned on again within a specified period of time after the power source was turned off.

[0058]

In the twenty-fifth aspect, when the power source is turned on within a specified period of time, correction of the driving signal suitable for the ink temperature can be performed by use of the head temperature information before the power source was turned off.

[0059]

A twenty-sixth aspect of the present invention is the ink-jet recording method according to any one of the twentieth to twenty-fifth aspects, characterized in that a driving voltage of a driving pulse contained in the driving signal, which is capable of ejecting ink droplets, is set up in said step of correcting the driving signal.

[0060]

In the twenty-sixth aspect, the recording head can be driven at the driving voltage suitable for the ink temperature by setting up the driving voltage.

[0061]

A twenty-seventh aspect of the present invention is the

ink-jet recording method according to any one of the twentieth to twenty-sixth aspects, characterized in that a waveform of the driving pulse contained in the driving signal, which is capable of ejecting ink droplets, is changed in said step of correcting the driving signal.

[0062]

In the twenty-seventh aspect, the recording head can be driven with the waveform of the driving pulse suitable for the ink temperature by deforming the waveform of the driving pulse.

[0063]

A twenty-eighth aspect of the present invention is the ink-jet recording method according to any one of the twentieth to twenty-seventh aspects, characterized in that the driving signal in the case of having said recording head perform a preparatory ejection operation is also corrected in said step of correcting the driving signal.

[0064]

In the twenty-eighth aspect, plugging of a nozzle orifice is surely prevented and unnecessary ejection due to the preparatory ejection can be suppressed by correcting the driving signal of the preparatory ejection operation.

[0065]

A twenty-ninth aspect of the present invention is an ink-jet recording method of performing printing by use of a recording head which ejects ink from an ink reservoir portion, which comprises the steps of: obtaining an ink reservation amount in the ink reservoir portion as well as obtaining a temperature

change amount of the recording head; and changing control of a preparatory ejection operation based on the temperature change amount of the recording head and the ink reservation amount.

[0066]

In the twenty-ninth aspect, plugging of the nozzle orifice is surely prevented by changing control of the preparatory ejection operation in accordance with an actual ink temperature.

[0067]

A thirtieth aspect of the present invention is the ink-jet recording method according to the twenty-ninth aspect, characterized in that said step of changing control of the preparatory ejection operation changes a driving voltage and driving time that form an ejection waveform in the preparatory ejection operation.

[0068]

In the thirtieth aspect, since an ejection waveform of the preparatory ejection operation is changed to a waveform suitable for an actual ink temperature, ink is surely ejected and ejection of unnecessary ink is suppressed.

[0069]

A thirty-first aspect of the present invention is the ink-jet recording method according to any one of the twenty-ninth and thirtieth aspects, characterized in that the number of times of ejection in the preparatory ejection operation is changed in said step of changing control of the preparatory ejection operation.

[0070]

In the thirty-first aspect, an ejection amount of ink by the preparatory ejection operation is adjusted, thus ink of increased viscosity is surely ejected and ejection of any unnecessary ink is suppressed.

[0071]

A thirty-second aspect of the present invention is the ink-jet recording method according to any one of the twenty-ninth to thirty-first aspects, characterized in that an interval of the preparatory ejection operations is changed in said step of changing control of the preparatory ejection operation.

[0072]

In the thirty-second aspect, since the frequency of the preparatory ejection operations is changed, ink of increased viscosity is surely ejected and ejection of unnecessary ink is suppressed.

[0073]

A thirty-third aspect of the present invention is the ink-jet recording method according to any one of the twenty-ninth to thirty-second aspects, characterized in that an ejection cycle in the preparatory ejection operation is changed in said step of changing control of the preparatory ejection operation.

[0074]

In the thirty-third aspect, the ink ejection amount by the preparatory ejection operation is adjusted and stability of ink ejection is improved, thus ink of increased viscosity is surely ejected and ejection of unnecessary ink is suppressed.

[0075]

A thirty-fourth aspect of the present invention is the ink-jet recording method according to any one of the twenty-ninth to thirty-third aspects, characterized in that said step of obtaining the temperature change amount of the recording head includes the steps of: detecting said recording head temperature and storing this head temperature information which is detected.

[0076]

In the thirty-fourth aspect, since the recording head temperature is detected and the head temperature information is stored, the temperature change amount of the recording head can be obtained relatively easily.

[0077]

A thirty-fifth aspect of the present invention is the ink-jet recording method according to the thirty-fourth aspect, characterized in that said head temperature information since the time a power source is turned on is stored in said step of storing the head temperature information.

[0078]

In the thirty-fifth aspect, since the head temperature information is stored since the time the power source is turned on, the temperature change amount of the recording head since the time the power source is turned on can be obtained and the change of control of the preparatory ejection operation suitable for an ink temperature can be performed based on the additional head temperature information.

[0079]

A thirty-sixth aspect of the present invention is the

ink-jet recording method according to any one of the thirty-fourth and thirty-fifth aspects, characterized in that said head temperature information in a standby state of a recording operation is stored in said step of storing the head temperature information.

[0080]

In the thirty-sixth aspect, since the head temperature information is stored even in the standby state, the change of control of the preparatory ejection operation suitable for the ink temperature can be performed based on the additional head temperature information.

[0081]

A thirty-seventh aspect of the present invention is the ink-jet recording method according to any one of the thirty-fourth to thirty-sixth aspects, characterized in that said head temperature information stored in said step of storing head temperature information is still kept after the power source was turned off.

[0082]

In the thirty-seventh aspect, since the head temperature information is still kept after the power source was turned off, the change of control of the preparatory ejection operation suitable for the ink temperature can be performed based on the additional head temperature information when the power source is turned on again.

[0083]

A thirty-eighth aspect of the present invention is the

ink-jet recording method according to the thirty-seventh aspect, characterized in that, in said step of obtaining the temperature change amount of the recording head, the temperature change amount is obtained by use of said head temperature information stored when the power source is turned on again within a specified period of time after the power source was turned off.

[0084]

In the thirty-eighth aspect, when the power source is turned on within a specified period of time, the change of control of the preparatory ejection operation suitable for the ink temperature can be performed by use of the head temperature information before the power source was turned off.

[0085]

A thirty-ninth aspect of the present invention is a recording medium storing a program for correcting a driving signal of an ink-jet recording apparatus that executes printing by use of a recording head ejecting ink from an ink reservoir portion, said recording program being characterized in that the program causes an ink reservation amount in said ink reservoir portion to be obtained as well as a temperature change amount of said recording head to be obtained, and causes a driving signal to be corrected based on said temperature change amount of the recording head and said ink reservation amount.

[0086]

In the thirty-ninth aspect, by executing the program stored in the recording medium, the driving signal can be corrected as suitable for an actual ink temperature in accordance with

the temperature change amount of the recording head and the ink reservation amount, and the recording head can record an image of stable quality regardless of change in an environmental temperature.

[0087]

A fortieth aspect of the present invention is a recording medium storing a program for correcting a driving signal of an ink-jet recording apparatus that executes printing by use of a recording head ejecting ink from an ink reservoir portion, characterized in that an ink reservation amount in the ink reservoir portion is caused to be obtained as well as a temperature change amount of the recording head is caused to be obtained, and control of a preparatory ejection operation is caused to be changed based on the temperature change amount of the recording head and the ink reservation amount.

[0088]

In the fortieth aspect, by executing the program stored in the recording medium, control of the preparatory ejection operation can be changed as suitable for an actual ink temperature in accordance with the temperature change amount of the recording head and the ink reservation amount, and the recording head can record an image of stable quality regardless of change in an environmental temperature.

[0089]

[Embodiments of the Invention]

Embodiments of the present invention will be described

in detail with reference to the drawings as follows.

[0090]

(Embodiment 1)

Fig. 1 is a perspective view of an ink-jet printer 1 that is a representative ink-jet recording apparatus.

[0091]

In the ink-jet printer 1, a carriage 2 is movably installed on a guide member 3, and the carriage 2 is connected to a timing belt 6 that is hooked on a driving pulley 4 and a free rotating pulley 5. The driving pulley 4 is jointed to a rotation axis of a pulse motor 7, and the carriage 2 is made to move (main-scan) in the width direction of a recording paper 8 by drive of the pulse motor 7.

[0092]

At an opposite surface (a bottom surface) to the recording paper 8 of the carriage 2, a recording head 11 is installed. This recording head 11 ejects ink supplied from an ink cartridge 12 (a kind of ink reservoir portion of the present invention) mounted on the carriage 2 or ink supplied from an ink tank (a kind of ink reservoir portion of the present invention, not shown) connected via an ink supplying tube, from a nozzle orifice 13 (see Fig. 2) as ink droplets.

[0093]

In addition, to the carriage 2, installed is a head substrate (not shown) on which various devices for driving the recording head 11 and a temperature sensor 14 (see Fig. 3) and the like are mounted. The above-described temperature sensor

14 functions as temperature detecting means of the present invention, and it is composed of, for example, a temperature sensitive device capable of detecting a temperature such as a thermistor. This temperature sensor 14 detects an environmental temperature in the vicinity of the recording head 11, and outputs it as head temperature information.

[0094]

In an edge portion area outside a recording area that is within a moving range of the carriage 2, a home position and a standby position of the carriage 2 are set.

[0095]

The home position is a place where the recording head 11 moves to in the case when a power source was turned off or recording is not performed for a long period of time. When the recording head 11 is positioned, a cap member 15 of a capping mechanism closes the nozzle orifice 13.

[0096]

The standby position is a starting position of scanning the recording head 11. That is to say, the recording head 11 usually stands by at the standby position, and at the time of a recording operation, the recording head 11 is made to scan from the standby position to the recording region side, and then it returns to the standby position when the recording operation ends. And, a wiper member 16 of a cleaning mechanism is disposed under the standby position.

[0097]

At the time of recording operation, the ink-jet printer

1 of the above-described constitution ejects ink droplets from the recording head 11 while synchronizing with the main scanning of the carriage 2, rotates a platen 17 linking with reciprocating motion of the carriage 2, and moves the recording paper 8 in the paper feeding direction (that is, sub-scan). As a result, images, characters and the like based on printing data are recorded on the printing paper 8.

[0098]

Next, description will be made for the recording head 11.

[0099]

The recording head 11 as shown in Fig. 2 comprises an ink chamber 21 to which ink from the ink cartridge 12 is supplied, a nozzle plate 22 where a plurality (for example, 64 pieces) of nozzle orifices 13 are arranged in the sub-scanning direction, and a pressure chamber 24 provided in plural corresponding to each of the nozzle orifices 13 that expands and contracts due to deformation of a piezoelectric element 23. Then, the ink chamber 21 and the pressure chamber 24 are communicatively connected with an ink supply orifice 25 and a supplying side communicating bore 26, and the pressure chamber 24 and the nozzle orifice 13 are communicatively connected with a first nozzle communicating bore 27 and a second nozzle communicating bore 28. That is to say, a series of ink flow paths from the ink chamber 21 reaching the nozzle orifice 13 through the pressure chamber 24 is formed for each nozzle orifice 13.

[0100]

The above-described piezoelectric element 23 is so-called

a piezoelectric element 23 of warp vibration mode. When this piezoelectric element 23 of warp vibration mode is used, charging with electricity leads the piezoelectric element 23 to contract in the orthogonal direction of the electric field to allow the pressure chamber 24 to contract. When the charged piezoelectric element 23 is discharged, the piezoelectric element 23 expands in the orthogonal direction of the electric field to allow the pressure chamber 24 to expand.

[0101]

In the recording head 11, since the capacity of the corresponding pressure chamber 24 changes with charge/discharge to the piezoelectric element 23, ink droplets can be ejected from the nozzle orifice 13 by utilizing pressure fluctuation of the pressure chamber 24.

[0102]

Note that, instead of the above-described piezoelectric element 23 of warp vibration mode, a piezoelectric element 23 of so-called longitudinal vibration mode may be used. This piezoelectric element 23 of longitudinal vibration mode is a piezoelectric element 23 that expands the pressure chamber 24 by deformation due to charge and contracts the pressure chamber 24 by deformation due to discharge.

[0103]

Next, electric constitution of the printer 1 will be described. As shown in Fig. 3, the printer 1 comprises a printer controller 31 and a print engine 32.

[0104]

First, description will be made for the printer controller 31.

[0105]

The printer controller 31 includes: a sensor interface 33 (hereinafter referred to as a "sensor I/F 33") for receiving head temperature information from the above-described temperature sensor 14; an external interface 34 (hereinafter referred to as an "external I/F 34") for receiving various data from a host computer (not shown) and the like; a RAM 35 for temporarily storing various data; a backup memory 36 having a holding function of stored information; a ROM 37 storing a control program and the like; a control section 38 that is constituted by including a CPU and the like; an oscillation circuit 39 for generating a clock signal; a driving signal generating circuit 40 for generating a driving signal to be supplied to the recording head 11; a power source generating section 41 for generating a power source to be used in the driving signal generating circuit 40; and an internal interface 42 (hereinafter referred to as an "internal I/F 42") for transmitting to the print engine 32 the driving signal, dot pattern data (type-printing data) developed on a basis of printing data, and the like.

[0106]

The sensor I/F 33 receives head temperature information that was detected by the temperature sensor 14 and converted into a digital quantity by an A/D converter 45 (analog/digital converter).

[0107]

The external I/F 34 receives the printing data composed of, for example, a character code, a graphic function, image data and the like, from the host computer or the like. In addition, a busy signal (BUSY) and an acknowledge signal (ACK) are outputted to the host computer or the like via this external I/F 34.

[0108]

The RAM 35 functions as a receiving buffer, an intermediate buffer, an output buffer and a working memory (not shown). And, the receiving buffer temporarily stores the printing data received via the external I/F 34, the intermediate buffer stores intermediate code data converted by the control section 38, and the output buffer stores dot pattern data. These dot pattern data is composed of the type-printing data obtained by decoding (translating) gradation data.

[0109]

The backup memory 36 functions as temperature information storing means of the present invention, and comprises a storing section 46 for storing the head temperature information obtained via the sensor I/F 33 and a power source supply section 47 composed of a secondary cell, a capacitor and the like. The power source supply section 47 functions as power source supply means, and supplies a backup power source to the storing section 46 in order to keep stored contents even during the time when the main power source of the printer 1 is turned off.

[0110]

Note that the backup memory 36 is not limited to the one composed of the storing section 46 and the power source supply

section 47, but may be composed of nonvolatile memory such as an EEPROM.

[0111]

The ROM 37 stores a control program (control routine) for performing various data processing, font data, a graphic function and the like. In addition, the ROM 37 also functions as signal correction information storing means, and stores driving signal adjustment data (signal correction information) for correcting a driving voltage (a wave-height value), a waveform of a driving pulse and the like constituting the driving signal according to the head temperature information (an ink temperature).

[0112]

Note that the ROM 37 is made to be a rewritable memory such that various control programs, driving signal correction data and the like stored here can be rewritten. Such a variety of programs for rewriting are read from a recording medium 43 such as a floppy disk and a CD-ROM, which are directly connected via the external I/F 34 or connected via the host computer.

[0113]

Alternatively, the control program read from the storing medium 43 may be read into a nonvolatile memory or the like provided separately from the ROM 37 to activate.

[0114]

The control section 38 operates by activating various control programs stored in the ROM 37, performs a variety of controls, and furthermore, reads out the printing data in the receiving buffer, and allows the intermediate buffer to store

intermediate code data obtained by converting the printing data read out. Moreover, it also analyzes intermediate code data read from the intermediate buffer, refers to the font data and the graphic function and the like stored in the ROM 37, then develops it into the dot pattern data. And then, the control section 38 allows the output buffer to store the dot pattern data after necessary decoration processing is provided.

[0115]

Then, when the dot pattern data for one line recordable by one time of main scanning by the recording head 11 are obtained, this dot pattern data for the one line are serially outputted from the output buffer to the recording head 11 via the internal I/F 42. And, when the dot pattern data for the one line are outputted from the output buffer, intermediate code data previously developed are deleted from the intermediate buffer, after which development processing for the next intermediate code data is performed.

[0116]

And, as shown in Fig. 4, in addition to the above-described constitution the control section 38 comprises an ink reservation amount obtaining means 61, a temperature change amount obtaining means 62 and a driving signal correcting means 63.

[0117]

The ink reservation obtaining means 61 obtains an ink reservation amount (i.e., a residual ink amount) of the ink cartridge 12 based on an ejection amount of ink and the like.

[0118]

For example, replacement of a new ink cartridge 12, ink refill into an ink tank or the like is recognized based on an input signal from a maintenance switch (not shown), and the ink reservation amount information is reset when the ink cartridge 12 is replaced or ink refill into the ink tank is performed. Here, initial ink amount information such as a capacity of the ink cartridge 12 or a capacity of the ink tank is stored in the backup memory 36 as the ink reservation amount information.

[0119]

Then, the ink ejection amount associated with recording operations and flushing operations are sequentially recognized by counting times of ejection of ink droplets and the like, and the ink reservation amount (the residual ink amount) is obtained by subtracting this ejection amount from the initial ink amount information.

[0120]

And, the temperature change amount obtaining means 62 performs control to allow the backup memory 36 to store the head temperature information from the temperature sensor 14 inputted via the A/D converter 45. For example, the head temperature information from the temperature sensor 14 is stored in the backup memory 36 every time when a certain period of time passes.

[0121]

Then, this temperature change amount obtaining means 62 obtains a temperature change amount of the recording head 11 based on the head temperature information stored in the backup memory 36.

[0122]

In addition, the driving signal correcting means 63 selects a correction data out of driving signal correction data stored in the ROM 37, based on the temperature change amount of the recording head 11 obtained by the temperature change amount obtaining means 62 and the ink reservation amount of the ink cartridge 12 obtained by the ink reservation amount obtaining means 61, and outputs a control signal (driving signal correction information) to the driving signal generating circuit 40.

[0123]

Here, the driving signal generating circuit 40 functions as driving signal generating means on the present invention, and generates a driving signal for working the piezoelectric element 23 of the recording head 11. For example, it generates a driving signal (COM) in which a plurality of driving pulses as shown in Fig. 7 (a) are connected in series.

[0124]

The exemplified driving pulse is composed of: an expansion element (discharge pulse) P1 in which electric potential changes by descending from the middle potential Vm to the lowest potential VL in a constant slope; a first holding element (holding pulse) P2 that keeps the lowest potential VL; an ejection element (charge pulse) P3 in which electric potential ascends from the lowest potential VL to the highest potential VP in a specified slope; a second holding element P4 that keeps the highest potential VP; and a damping element P5 in which electric potential changes by descending from the highest potential VP to the middle

potential Vm in a specified slope.

[0125]

When the above-described expansion element P1 is applied to the piezoelectric element 23, the piezoelectric element 23 deforms in the direction that it expands the volume of the pressure chamber 24, and generates a negative pressure in the pressure chamber 24. The expanding state of the pressure chamber 24 is kept during the period when the first holding element P2 is being applied. Following this first holding element P2, the ejection element P3 is supplied. When the ejection element P3 is supplied, the piezoelectric element 23 deforms such that the pressure chamber 24 contracts. This contraction of the pressure chamber 24 allows ink pressure in the pressure chamber 24 to increase, and ink droplets are ejected from the nozzle orifice 13. The contracting state of the pressure chamber 24 is kept during the period when the second holding element P4 is being supplied. Thereafter, the damping element P5 is supplied to the piezoelectric element 23 in order to converge vibration of a meniscus (a free surface of ink exposed at the nozzle orifice 13) in a short time.

[0126]

The driving signal generating circuit 40 also generates a driving signal that is corrected into a control signal (driving signal correction information) outputted from the control section 38. For example, it increases and decreases a driving voltage (a wave-height value) Vh, or generates a driving signal in which the waveform is adjusted. Note that this correction

of the driving signal will be described later in detail.

[0127]

Next, description will be made for the print engine 32.

[0128]

The print engine 32 is composed of a paper feeding motor 50, the pulse motor 7 and an electric driving system 51 of the recording head 11.

[0129]

The electric driving system 51 of the recording head 11 comprises a shift register circuit 52, a latching circuit 53, a level shifter circuit 54, a switching circuit 55 and the piezoelectric element 23, and they are electrically connected in the order of the shift register circuit 52, the latching circuit 53, the level shifter circuit 54, the switching circuit 55 and the piezoelectric element 23. These circuits (the shift register circuit 52, the latching circuit 53, the level shifter circuit 54, the switching circuit 55 and the piezoelectric element 23) are provided in plural numbers corresponding to the respective nozzle orifices 13 of the recording head 11.

[0130]

In this electric driving system 51, in the case when type-printing data added to the switching circuit 55 is "1", the switching circuit 55 is rendered in a connecting state and the driving signal (COM) is directly applied to the piezoelectric element 23, and then each piezoelectric element 23 deforms according to waveform (electric potential) of the driving signal. On the contrary, in the case when the type-printing data added

to the switching circuit 55 is "0", the switching circuit 55 is rendered in a non-connecting state, and supply of the driving signal to the piezoelectric element 23 is interrupted.

[0131]

As above, since the driving signal can be selectively supplied to each piezoelectric element 23 based on the type-printing data, ink droplets can be selectively ejected from the nozzle orifice 13 depending on the type-printing data.

[0132]

Next, description will be made for an operation of the printer 1 centering on the correction of the driving signal based on the temperature change amount of the recording head 11 and the ink reservation amount of the ink cartridge 12.

[0133]

Here, Fig. 5 is a flowchart explaining the operation of the printer 1, Fig. 6 is a view explaining a difference in the change of ink temperature accompanied with the ink reservation amount (residual ink amount), and Fig. 7 is a view explaining a driving pulse constituting a driving signal.

[0134]

When the power source is turned on to the printer 1 (S10), the temperature change amount obtaining means 62 obtains the head temperature information which the temperature sensor 14 is detecting (S11), and the obtained head temperature information is stored in the backup memory 36 as the temperature information storing means (S12). In this embodiment, the head temperature information since the time the power source is turned on is stored

in the backup memory 36 as above.

[0135]

Obtaining processing and storing processing of this head temperature information are iterated at a specified period of time (for example, every one minute) until the printing data (a printing signal) from the host computer is received (S13). In this way, the head temperature information in a standby state, where no recording operation is performed, is stored in the backup memory 36 at every specified period of time.

[0136]

Then, upon having received the above-described printing data, the temperature change amount obtaining means 62 obtains the head temperature information from the temperature sensor 14 (S14), and stores the obtained head temperature information in the backup memory 36 (S15). Thereafter, the ink reservation amount obtaining means 61 obtains the ink reservation amount (residual ink amount) (S16). The ink reservation amount is obtained, for example, as shown above, by subtracting the ink ejection amount from the initial ink amount information.

[0137]

When the ink reservation amount is obtained, the driving signal correcting means 63 performs correction of the correcting signal (S17).

[0138]

In this processing of step S17, the temperature change amount obtaining means 62 first obtains the temperature change amount of the recording head 11, for example, a change amount

of the head temperature information corresponding to a unit time, based on the head temperature information stored in the backup memory 36 (the temperature information storing means).

[0139]

Various methods can be used in order to obtain this temperature change amount. For example, the temperature change amount may be calculated by using the head temperature information obtained immediately after the power source was turned on and the latest head temperature information, or, the temperature change amount may be calculated with the method of least-squares by using a plurality of head temperature information between the head temperature information before a specified period of time and the latest head temperature information.

[0140]

Upon having obtained the temperature change amount, the driving signal correcting means 63 estimates a temperature of ink reserved in the ink cartridge 12 (or the ink tank). In this processing, the control section 38 estimates an ink temperature at that time by adding in the temperature change amount and the ink reservation amount to the latest head temperature information.

[0141]

That is to say, a state in which the temperature change amount per unit time is large means that the environmental temperature (the room temperature) at a place where the printer 1 is used is greatly changed in a short time. Here, change of

the ink temperature is slower than that of the environmental temperature because of a difference of heat capacity and the like. Accordingly, when the temperature change amount per unit time is large, the ink temperature is estimated by taking into account the fact that the ink temperature changes more slowly than the head temperature information. For example, in the case where the temperature change amount per unit time is large in the positive direction (+ direction), the ink temperature is set at a lower value than that of the latest head temperature information according to this temperature change amount because in this case, it is a state in which the temperature of the recording head 11 (that is, the environmental temperature) is sharply increasing. Conversely, in the case where the temperature change amount per unit time is large in the negative direction (- direction), the ink temperature is set at a higher value than that of the latest head temperature information according to this temperature change amount.

[0142]

On the other hand, a state that the above-described temperature change amount is constant for a relatively long period of time (for example approximately one to two hours) means that the environmental temperature is stable at a certain temperature. In this case, since it is presumed that the ink temperature is substantially the same as the environmental temperature, the ink temperature is made coincident with the latest head temperature information.

[0143]

Moreover, a degree of change of the ink temperature relative to the environmental temperature differs depending on the ink reservation amount.

[0144]

Here, Fig. 6 is a graph showing the change of ink temperature with the passage of time in the case where three pieces of the ink cartridges 12 with different ink reservation amounts were cooled down until the ink temperatures reached 0°C, thereafter, each ink cartridge 12 was left in an environment of 20°C. In Fig. 6, a line segment added with a "triangle" mark shows a state where ink is full, a line segment added with a "square" mark shows a state where the ink reservation amount is almost half-full, and a line segment added with a "circle" mark shows a state that the ink reservation amount is about one third.

[0145]

As is understood from Fig. 6, recognized is a fact that the less the ink reservation amount in the ink cartridge is, the quicker the ink temperature ascends to the environmental temperature. For example, in the ink cartridge 12 with about one third of ink reservation amount, the ink temperature ascends to the same degree as the environmental temperature in about thirty minutes after being left. On the contrary, in the ink cartridge 12 with ink reservation at about half-full, it requires about sixty minutes until the ink temperature ascends to the same degree as the environmental temperature, and it requires about ninety minutes for a full ink cartridge 12.

[0146]

In this way, the more the ink reservation amount is, the slower the ink temperature changes. Conversely, the less the ink reservation amount is, the faster the ink temperature changes. Therefore, the ink temperature is set closer to the latest head temperature information as the ink reservation amount is less.
[0147]

Note that, in the embodiment, a relation between the above-described temperature change amount and the ink reservation amount is stored in the ROM 37 as table information (ink temperature estimation information).
[0148]

Upon having estimated the ink temperature, a driving waveform is corrected based on this ink temperature. That is to say, a waveform of a driving voltage Vh (a wave-height value) of a driving pulse is changed according to the ink temperature.
[0149]

Here, the driving signal correcting means 63 refers to the driving signal adjustment data. When the ink temperature is lower than a standard temperature, as shown in Fig. 7(b), the driving voltage Vh of the driving pulse is set larger than a base driving voltage [the driving voltage Vh of the driving pulse in Fig. 7 (a)] in order to render the force for ejecting ink droplets stronger than usual. To the contrary, when the ink temperature is higher than the standard temperature, as shown in Fig. 7(c), the driving voltage Vh of the driving pulse is set smaller than the base driving voltage in order to render the force for ejecting ink droplets weaker than usual.

[0150]

Incidentally, when the force for ejecting ink droplets is changed in this way, the flying speed of ink droplets also changes according to the magnitude of the ejecting force. For example, in the case when the driving voltage Vh is set larger than the base driving voltage, the flying speed of ink droplets becomes faster than the base flying speed, and when the driving voltage Vh is set smaller than the base driving voltage, the flying speed of ink droplets becomes slower than the base flying speed.

[0151]

Accordingly, in the embodiment, the flying speed of ink droplets is made to be coincident with the standard speed by correcting the waveform as well.

[0152]

In the case where the driving voltage Vh is set higher than the base driving voltage, correction of the driving pulse as exemplified in Fig. 8 (a) to (c) is performed in order to suppress the flying speed of ink droplets. That is, in Fig. 8 (a), an intermediate voltage (Vc) is made small by lowering the intermediate potential Vm less than the base intermediate potential [the intermediate potential Vm of the driving pulse in Fig. 7 (a)] . In Fig. 8 (b), the voltage slope of the expansion element P1 that allows the pressure chamber 24 to expand is set gently. In other words, supply time Twd1 of the expansion element P1 is set longer than the standard. In Fig. 8 (c), the first holding element P2 (a time component Twh1) for holding the

expanding state of the pressure chamber 24 is set longer than the standard.

[0153]

On the other hand, in the case where the driving voltage Vh is set lower than the base driving voltage, correction as exemplified in Figs. 9 (a) to (c) is performed in order to enhance the flying speed of ink droplets. That is, in Fig. 9 (a), the intermediate voltage (Vc) is made large by raising the intermediate potential Vm more than the base intermediate potential. In Fig. 9 (b), the voltage slope of the expansion element P1 that allows the pressure chamber 24 to expand is set steep. In other words, the supply time Twd1 of the expansion element P1 is set shorter than the standard. In Fig. 9 (c), the first holding element P2 (the time component Twh1) for holding the expanding state of the pressure chamber 24 is set shorter than the standard.

[0154]

Note that, in the driving signal correction processing of step S17, although the driving signal correcting means 63 estimates the ink temperature based on the temperature change amount and the ink reservation amount and thus the driving waveform is corrected based on this ink temperature, it is not limited to this method. In short, it is satisfactory if a correct driving signal is set up based on the temperature change amount and the ink reservation amount.

[0155]

For example, a constitution may be acceptable in which

each information of the latest temperature change amount, the temperature change amount per unit time and the ink reservation amount and parameters for defining a driving waveform (for example, intermediate potential, supply time Twd1 of the expansion element P1, supply time Twh1 of the holding element, a driving voltage Vh and the like) are arranged in a table and stored in the ROM 37, whereby the driving signal is corrected based on each of the information described above.

[0156]

Upon having corrected the driving signal as described above, a recording operation for one path (for one line) is performed by using the corrected driving signal (S18). In this recording operation, since ink droplets are ejected by using the driving pulse of which the driving voltage is adjusted according to the ink temperature, the ejection amount of ink droplets can be made constant even in a state where a temperature change amount per unit time is due to a sharp change in environmental temperature. In this way, the image quality of a recorded image can be stabilized.

[0157]

Upon having recorded for one path, an evaluation is made for existence of printing data for a following line (S19). Here, when printing data for a following line exists, processing proceeds to step S14 as described above for iterating the above-described recording operations (S14 to S19). On the other hand, when no printing data exists, processing proceeds to step S11, and the head temperature information in a standby state

is obtained at every specified period of time until printing data are received (S11 to S13).

[0158]

As above, in the embodiment, the temperature of the recording head 11 is measured and stored at every specified period of time since the time the power source is turned on, and correction of the driving signal is performed based on the temperature change amount and the ink reservation amount prior to printing one line. Therefore, a correct driving signal can be set for every recording of every one line, and thus an image of stable image quality can be recorded even if the room temperature changes sharply.

[0159]

And, since the amount of ink droplets can be made constant regardless of the change of the environmental temperature, the ink reservation amount can be accurately grasped. As a result, a blank printing phenomenon where a recording operation is performed despite running out of ink in the ink cartridge 12 or ink tank, or a defect of a replacement order for a cartridge or an ink filling order made despite there being sufficient ink reserved in the ink cartridge 12 or ink tank, can be surely prevented.

[0160]

Note that, in this embodiment, although correction of the driving signal based on the temperature change amount and the ink reservation amount is performed prior to starting recording for one line, correction timing is not limited to this. For example, the driving signal may be corrected prior to starting

recording for one page.

[0161]

In addition, an interval of obtaining the head temperature information is set at one minute. However, not limited to this, the interval may be set at an arbitrary period of time. For example, the head temperature information may be obtained every ten minutes.

[0162]

Further, regarding the ink reservation amount, obtaining the ink reservation amount will suffice. For this reason, a residual ink amount sensor for directly detecting an ink amount in the ink cartridge 12 may be provided, and the ink reservation amount may be detected based on a detecting signal from this residual ink amount sensor. Alternatively, with regards to resetting the ink reservation amount, a cartridge sensor for detecting mounting of the ink cartridge 12 may be provided on the carriage 2, so that replacement action or non-action of the ink cartridge 12 may be detected based on a detecting signal from the cartridge sensor, and the ink reservation amount may be automatically reset accompanied with the replacement.

[0163]

Incidentally, in the above-described embodiment, the temperature change amount is obtained by using the head temperature information after the power source of the printer 1 is turned on, and correction of the driving signal is performed. However, in the case where the power source is turned on again in a relatively short time after the power source of the printer

1 was turned off, correction of the driving signal can be performed with higher accuracy by using the head temperature information that had been stored until then.

[0164]

Next, description will be made for another embodiment constituted as above. Here, Fig. 10 is a flowchart explaining an operation of the printer 1 in this embodiment. Note that, in this flowchart, the same step numbers are denoted to the same processing as those of the previous embodiment (Fig. 5).

[0165]

When the power source to the printer 1 is turned on (S10), the control section 38 judges whether a specified period of time (for example, ten minutes) from a previous point of turning off the power source has passed or not (S21).

[0166]

This judgment is performed on a basis of, for example, time measurement information from a timer (not shown). This timer which functions as disconnection time measuring means, operates with a dedicated power source such as a secondary cell, thus the timer performs time measurement operations during a period when the power source of the printer 1 is turned off.

[0167]

The control section 38 obtains time measurement information from the timer immediately before the power source is turned off, and stores the obtained time measurement information in the backup memory 36. Then, it also obtains the time measurement information from the timer at the next time

the power source is turned on, and a passage of time since the previous point of turning off the power source is obtained by comparing the time measurement information at the point of turning off the power source stored in the backup memory 36 with the time measurement information at the point of turning on the power source obtained this time.

[0168]

Here, in the case when the passage of time obtained is within a specified period of time, that is, when a main power source is turned on again in a short time after the main power source of the printer 1 was turned off, the head temperature information is obtained from the temperature sensor 14 (S11) while the head temperature information stored in the backup memory 36 is retained (S22). And the obtained head temperature information is stored in the backup memory 36 functioning as the temperature information storing means (S12). Therefore, in this case, the head temperature information after the power source is turned on is stored in the backup memory 36, following the head temperature information already obtained.

[0169]

And upon having received the printing data (S13), it obtains the head temperature information (S14), stores it to the backup memory 36 (S15), and obtains the ink reservation amount (S16).

[0170]

Upon having obtained the ink reservation amount, the driving signal correcting means 63 performs correction of the

driving signal (S17). In this correction processing, the control section 38 (the temperature change amount obtaining means) obtains the temperature change amount by also using the head temperature information obtained a little before the power source is turned on in addition to the head temperature information obtained after the power source is turned on. Then, the driving signal is corrected based on the temperature change amount thus obtained. For this reason, a more accurate temperature change amount can be obtained. Thus, correction of the driving signal can be performed more appropriately.
[0171]

Upon having corrected the driving signal, the recording operation is performed (S18), subsequently, evaluation is made whether any subsequent printing data is present or not (S19), and the above-described processing (processing from S11 on, or from S14 on) is iterated according to the result of the judgment.
[0172]

On the other hand, in step S21 as described above, when it is judged that the passage of time exceeds a specified period of time, the head temperature information stored in the backup memory 36, that is, the head temperature information obtained prior to turning off the power source is discarded (S23). Then, the processing proceeds to step S11 to perform the above-described processing. In this case, the operation will be the same as those of the above-described first embodiment.
[0173]

As above, in this embodiment, in the case when the power

source is turned on again in a relatively short time after the main power source of the printer 1 was turned off, the driving signal is corrected by using the head temperature information obtained before the power source was turned off. In this way, when the power source is turned on again after a relatively short time, correction of the driving signal can be performed by using more head temperature information. As a result, correction of the driving waveform can be performed more appropriately, thus attempting further stabilization of the image quality.

[0174]

Incidentally, each of the above embodiments has a constitution such that the head temperature information is obtained at every specified period of time, which begins since the time the power source of the printer 1 is turned on. However, the head temperature information may be constituted as interlocking with the recording operation.

[0175]

Next, description will be made for another embodiment constituted as above with reference to the flowchart in Fig. 11.

[0176]

When the power source is turned on to the printer 1 (S30), processing proceeds to a standby state (S31). On this standby state, the control section 38 obtains the head temperature information from the temperature sensor 14 as initial temperature information, and stores the obtained head temperature information in the backup memory 36 functioning as the

temperature information storing means.

[0177]

Thereafter, the control section 38 monitors the printing data, and stands by until these printing data are received (S32). Upon having received the printing data, the control section 38 obtains the head temperature information (S33), and stores the obtained head temperature information in the backup memory 36 (S34).

[0178]

Upon having the head temperature information stored in the backup memory 36, the control section 38 obtains the ink reservation amount (the residual ink amount) in the ink cartridge 12 (S35), and performs correction of the driving signal (S36). In this correction processing, the temperature change amount of the recording head 11 is obtained based on the latest head temperature information and the head temperature information obtained before that. Then, the driving signal is corrected based on the obtained temperature change amount and the ink reservation amount. Note that, in an initial recording operation after turning on the power source of the printer 1, the temperature change amount is obtained by using the head temperature information obtained in the standby state.

[0179]

Upon having corrected the driving signal, recording for one line is performed with the corrected driving signal (S37). Also in this recording operation, recording is performed with an appropriate ink amount by considering the ink temperature,

as similarly to each aforementioned embodiment.

[0180]

Upon having performed the recording operation, it judges whether the subsequent printing data is present or not (S38), and iterates the above-described processing according to this judgment result. Here, in the case when the subsequent printing data is not present, it proceeds to step S32 and stands by until receiving the subsequent printing data. On the other hand, in the case when the subsequent printing data is present, it proceeds to step S33 to obtain the head temperature information, and allows the head temperature information obtained in step S34 to be stored in the backup memory 36. Then, at this point, the driving waveform is corrected using the obtained head temperature information (S36).

[0181]

In this way, in this embodiment, every time the printing data is inputted, i.e., while every recording operation for one line is carried out, the head temperature information is obtained prior to this recording operation, and the obtained head temperature information is stored in the backup memory 36 (the temperature information storing means). In this way, in a constitution of obtaining the head temperature information as it corresponds to a recording operation for one line and allowing the backup memory 36 to store it, it is possible to perform correction of the driving signal properly while achieving a small quantity of the head temperature information to be stored in the backup memory 36.

[0182]

Moreover, based on a similar concept, the head temperature information may be obtained prior to this recording operation and stored in the backup memory 36, during every performance of a recording for one page.

[0183]

Note that various additions and changes can be made within the scope of the present invention as described above.

[0184]

For example, the ink-jet recording apparatus is not limited to an ink-jet recording apparatus having the recording head including a piezoelectric element as a pressure generating element, but an ink-jet recording apparatus including a magnetostrictive element as a pressure generating element may be also used.

[0185]

Alternatively, an exothermic element may be used as a pressure generating element. A similar effect can be obtained in an ink-jet recording apparatus including a recording head that ejects ink droplets by expanding/contracting bubbles in the pressure chamber with heat generated by the exothermic element.

[0186]

Moreover, in the above-described examples, the driving signal for normal printing is corrected based on the temperature change amount; however, flushing may be also performed before a start of printing or during printing, by use of the corrected

driving signal. Thus, appropriate flushing can be performed with the driving signal suitable for the actual ink temperature.

[0187]

(Embodiment 2)

In the above-described embodiment, the driving signal at printing is corrected based on the ink reservation amount and the temperature change amount of the recording head 11. However in this embodiment 2, it represents an example of changing control of flushing based on the ink reservation amount and the temperature change amount of the recording head.

[0188]

Note that, flushing means ejection of the ink in the nozzle orifice 13 and the vicinity thereof by ejecting ink droplets in a state that the recording head 11 stops outside of an area where it opposes to the recording paper 8, at a standby position for example, at a specified period of time, for example, before the start of printing or an interval of printing, in order to solve such problems as occurrence of plugging of the nozzle orifice caused by an increase of ink viscosity due to a change of the ink temperature and the like accompanied with a change of an environmental temperature of surroundings.

[0189]

Now, Fig. 12 shows a constitution of the control section according to the embodiment 2.

[0190]

As shown in Fig. 12, this embodiment is similar to the above-described embodiment 1 except that preparatory ejection

controlling means 64 and changing means 65 are provided instead of the driving signal correcting means 63.

[0191]

The preparatory ejection controlling means 64 allows the recording head 11 to execute flushing via the driving signal generating circuit 40, based on various setting conditions of flushing changed by the changing means 65.

[0192]

The changing means 65 changes control of the preparatory ejection controlling means 64 based on the temperature change amount of the recording head obtained by the temperature change amount obtaining means 62 and the ink reservation amount obtained by the ink reservation amount obtaining means 61.

[0193]

Here in this embodiment, the changing means 65 estimates an actual ink temperature in the ink cartridge based on a temperature correcting table, for example, as shown in Table 1 below, and changes various setting such as the waveform of the driving pulse for flushing according to the actual ink temperature estimated. Note that, the following Table 1 shows coefficients for estimating, by operation, the actual ink temperature by variation of the residual ink amounts (%), relevant to the temperature change amount (℃/ min) of the recording head 11 obtained by the temperature change amount obtaining means 62.

[0194]

[Table 1]

Temperature change ratio (°C/min)	Residual ink amount (%)										
	0	10	20	30	40	50	60	70	80	90	100
-10.00	1.0	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80
• • •	• •	• •	• •	• •	• •	• •	• •	• •	• •	• •	• •
-0.10	1.0	1.050	1.050	1.050	1.100	1.100	1.100	1.100	1.150	1.150	1.150
-0.05	1.0	1.050	1.050	1.050	1.050	1.050	1.050	1.050	1.100	1.100	1.100
-0.00	1.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.05	1.0	0.950	0.950	0.950	0.950	0.950	0.950	0.950	0.900	0.900	0.900
0.10	1.0	0.950	0.950	0.950	0.900.	0.900	0.900	0.900	0.850	0.850	0.850
0.15	1.0	0.950	0.950	0.900	0.900	0.850	0.850	0.850	0.800	0.800	0.750
0.20	1.0	0.950	0.900	0.900	0.850	0.850	0.800	0.750	0.750	0.700	0.700
• • •	• •	• •	• •	• •	• •	• •	• •	• •	• •	• •	• •
10.0	1.0	0.65	0.60	0.55	0.50	0.45	0.40	0.35	0.30	0.25	0.2

[0195]

As shown in Table 1, for example, when the head temperature detected by the temperature sensor 14 is 20°C, and the temperature change amount obtained by the temperature change amount obtaining means 62 is 0.10°C/min, a calculated ink temperature is 17°C because the coefficient is 0.85 when the residual ink amount detected by the ink reservation amount obtaining means 61 is 100%. On the other hand, when the residual ink amount is 30%, the coefficient is 0.95, then the calculated ink temperature is 19°C.

[0196]

Moreover, in this embodiment, the changing means 65 estimates the actual ink temperature by calculation, and changes

various setting such as the waveform by the estimated actual ink temperature. However, the embodiment is not limited to this. For example, without estimating the actual ink temperature, various setting such as the waveform may be directly changed by the temperature change amount of the recording head 11 obtained by the temperature change amount obtaining means 62 and the ink reservation amount obtained by the ink reservation amount, based on the respective correction tables for the waveform and the like, for example, the correction tables for the driving voltage, the driving time and the like.

[0197]

In the constitution of the embodiment described above, the changing means 65 is provided in order to change control of the preparatory ejection controlling means 64 with reference to the temperature correction table or the like, corresponding to the ink reservation amount detected by the ink reservation amount obtaining means 61 and the temperature change amount of the recording head 11 obtained by the temperature change amount obtaining means 62. Accordingly, ink droplets are favorably ejected at all times with flushing suitable for the actual ink temperature irrespective of a change of the environmental temperature and the sharp change of the temperature of the recording head 11 during continuous printing and so on. Thus, printing defects such as plugging of the nozzle orifice 13 can be surely prevented.

[0198]

Hereinbelow, an ink ejection operation of the ink-jet

recording apparatus according to this embodiment will be described with reference to a flowchart of Fig. 13.

[0199]

As shown in Fig. 13, when the power source is turned on in step S40, for example, a preparatory operation such as an operation confirmation is performed, then, a standby state of waiting for printing is initiated (step S41). Subsequently, when a type-printing signal is inputted in step S42, the temperature sensor 14 detects the head temperature in step S43, and the detection result is stored in the backup memory 36 by the temperature change amount obtaining means 62 in step S44. Thereafter, the ink reservation amount obtaining means 61 obtains the ink reservation amount of the ink cartridge in step S45, and the changing means 65 changes the waveform based on the correction table corresponding to the ink reservation amount and the temperature change amount of the recording head 11 obtained by the temperature change amount obtaining means 62 with the head temperature information stored in the backup memory 36 in step S46. Thereafter, in step S47, the preparatory ejection controlling means 64 allows the recording head 11 to execute flushing via the driving signal generating circuit 40. And in step S48, the controlling section 38 allows the recording head 11 to move for one path via the driving signal generating circuit 40 to execute printing. In step S49, in the case when another type-printing signal is present, the temperature change amount of the recording head 11 and the ink reservation amount are again obtained, and based on the obtained results, the changing means

65 changes the waveform of the driving pulse, and again performs flushing and the recording operation for one path (steps S43 to S48). The above-described steps S43 to S48 are performed repeatedly, and if the type-printing signal disappears in step S49, the standby state of step S42 is initiated.

[0200]

Note that in this embodiment, flushing is performed after the recording operation for one path. However, the embodiment is not limited to this, and flushing may be by all means performed after printing one page.

[0201]

Moreover, in this embodiment, the temperature change amount obtaining means 62 allows the backup memory 36 to store the temperature of the recording head 11 detected by the temperature sensor 14. However, the embodiment is not limited to this. For example, the temperature change amount obtaining means 62 may allow the backup memory 36 to store the temperature change amount of the recording head 11.

[0202]

(Embodiment 3)

In the above-described embodiment 2, the temperature change amount of the recording head 11 is detected after the type-printing signal is inputted. However this embodiment exemplifies that, even when the type-printing signal is not inputted, that is, in the standby state, the temperature of the recording head 11 is stored in the backup memory 36 by the temperature change amount obtaining means 62.

[0203]

Hereinbelow, an ink ejection operation of the ink-jet recording apparatus according to the embodiment 3 will be described with reference to the flowchart in Fig. 14. Note that in this flowchart, the same step numbers are added to the same processes as those in the above-described embodiment 2, and repetitive descriptions will be omitted.

[0204]

As shown in Fig. 14, when the power source is turned on in step S40, for example, a preparatory operation such as an operation confirmation is performed, and then the temperature sensor 14 detects the temperature of the recording head 11 in step S53, and the detection result is stored in the backup memory 36 by the temperature change amount obtaining means 62 in step S54. Thereafter, similarly to the above-described embodiment 2, steps S43 to S48 are performed. In step S49, in the case when printing data is present, steps S43 to S48 are performed repeatedly. In the case when the printing data is not present, the processing returns to step S53, and the temperature change amount obtaining means 62 allows the backup memory 36 to continuously store the temperatures of the recording head 11 detected by the temperature sensor 14 until the type-printing signal is inputted in step S42 (steps S53 and S54).

[0205]

In this embodiment, in addition to the constitution of the embodiment 2, the temperature of the recording head 11 is further stored in the backup memory 36 by the temperature change

amount obtaining means 62 even in the standby state. Thus, flushing suitable for the actual ink temperature can be executed by the changing means 65 based on any additional information.

[0206]

(Embodiment 4)

Fig. 15 is a block diagram of an ink-jet recording apparatus according to the embodiment 4.

[0207]

This embodiment is similar to the embodiment 3 except that the backup memory 36 that stores the head temperature information detected by the temperature sensor 14 is, for example, made of a nonvolatile memory such as an EEPROM, and that data controlling means 66 is provided.

[0208]

In the case where the period of time from turning off the power source to turning on the power source is equal to a specified period of time or longer, this data controlling means 66 discards the head temperature information stored in the backup memory 36, and allows the temperature sensor 14 to newly store the temperature of the recording head 11 in the backup memory 36. In the case within the specified period of time, the backup memory 36 is controlled as to keep the head temperature information before the power source is turned off, which is stored in the backup memory 36.

[0209]

By the data controlling means 66 as described above, the changing means 65 corrects the waveform of flushing based on

the head temperature information stored in the backup memory 36 before the power source was turned off and the ink reservation amount if the period of time that has passed since the power source is turned off is within the specified period of time. And if the specified period of time or longer has passed since the power source is turned off, the changing means 65 corrects the waveform of flushing based on the temperature change amount of the recording head 11 which is obtained by the temperature change amount obtaining means 62 based on the head temperature information stored in the backup memory 36 since the power source is turned on, and the ink reservation amount.

[0210]

Hereinbelow, an ink ejection operation of an ink-jet recording apparatus according to the embodiment 4 will be described with reference to a flowchart of Fig. 16. Note that in this flowchart, the same step numbers are added to the same processing as those in the above-described embodiment 3, and repetitive descriptions will be omitted.

[0211]

As shown in Fig. 16, when the power source is turned on in step S40, it is determined whether a specified period of time or longer has passed since the power source was turned off and until the power source is turned on in step S50. If the specified period of time or longer has passed (step S50: Yes), the data controlling means 66 discards the head temperature information stored in the backup memory 36 in step S51. If the specified period of time or longer has not passed (step S50: No), the data

controlling means 66 keeps the head temperature information stored in the backup memory 36 in step S52. Thereafter, similarly to the above-described embodiment 2, steps S53 to S49 are performed.

[0212]

In this embodiment, in addition to the constitution of the embodiment 3, depending on the period of time passed since the power source was turned off, selection can be made as to whether the head temperature information stored in the backup memory 36 is kept or discarded. Thus, in the case where the power source is turned on after a relatively short period of time, flushing suitable for the actual ink temperature can be performed by the changing means 65 by use of the head temperature information previously stored.

[0213]

(Embodiment 5)

In the above-described embodiments 2 to 4, flushing is performed before the recording operation for one path. However in this embodiment, represented is an example in which flushing of the above-described embodiment 3 is controlled by the passage of time since the last flushing is executed.

[0214]

Hereinbelow, an ink ejection operation of an ink-jet recording apparatus according to the embodiment 5 will be described with reference to the flowchart in Fig. 17. Note that, in this flowchart, the same step numbers are added to the same processes as those in the above-described embodiment 3, and

repetitive descriptions will be omitted.

[0215]

As shown in Fig. 17, when the power source is turned on in step S40, for example, a preparatory operation such as an operation confirmation is performed, and then the temperature sensor 14 detects the temperature of the recording head 11 in step S53. And this detection result is stored in the backup memory 36 by the temperature change amount detecting means 62 is step S54. Thereafter, when the type-printing signal is inputted in step S42, it is determined whether a specified period of time or longer has passed since the last flushing in step S60. If the specified period of time or longer has passed (step S60: Yes), steps S43 to S49 are performed similarly to the above-described embodiment 3. If the specified period of time or longer has not passed (step S60: No), steps S43 to S47, that is, obtainment of the temperature change amount of the recording head 11, detection of the ink reservation amount, correction of the waveform of flushing by the changing means 65 and flushing are not performed. In step S48, the control section 38 allows the recording head 11 to move for one path via the driving signal generating circuit 40 to execute printing. Thereafter, in the case where a type-printing signal is present in step S49, steps S60 to S48 are performed repeatedly.

[0216]

As above, in this embodiment, the interval of flushing is determined with the passage of time since the last flushing is performed irrespective of printing amounts such as one-path

type-printing.

[0217]

Even in such a constitution, similarly to the above-described embodiments 2 to 4, flushing suitable for the actual ink temperature can be performed by the changing means 65 corresponding to the ink reservation amount and the temperature change amount of the recording head 11.

[0218]

(Embodiment 6)

In the above-described embodiment 3, the control of the preparatory ejection controlling means is changed for each recording operation for one path by the changing means. However in this embodiment, when flushing is performed again within a regulated period of time, flushing is performed without changing control of the preparatory ejection controlling means by the changing means 65.

[0219]

Hereinbelow, an ink ejection operation of an ink-jet recording apparatus according to the embodiment 6 will be described with reference to the flowchart in Fig. 18. Note that in this flowchart, the same step numbers are added to the same processes as those in the above-described embodiment 3, and repetitive descriptions will be omitted.

[0220]

As shown in Fig. 18, when the power source is turned on in step S40, for example, a preparatory operation such as an operation confirmation is performed, and then the temperature

sensor 14 detects the temperature of the recording head 11 in step S53. This detection result is stored in the backup memory 36 as the temperature change amount of the recording head 11 by the temperature change amount obtaining means 62 in step S54. Thereafter, when the type-printing signal is inputted in step S42, it is determined whether a specified period of time or longer has passed since the last flushing in step S61. If the specified period of time or longer has passed (step S61: Yes), steps S43 to S49 are performed similarly to the above-described embodiment 3. If the specified period of time or longer has not passed (step S61: No), steps S43 to S46, that is, obtainment of the temperature change amount of the recording head 11, obtainment of the ink reservation amount, change of the waveform of flushing and so on are not performed, but the preparatory ejection controlling means 64 performs flushing in step S47. Then, in step S48, the control section 38 allows the recording head 11 to move for one path via the driving signal generating circuit 40 to execute printing. Thereafter, in the case where a type-printing signal is present in step S49, steps S43 to S48 are performed repeatedly.

[0221]

(Other embodiments)

The ink-jet recording head of the present invention has been described as above. However, it is not limited to these. For example, in the above-described embodiments 2 to 6, the changing means 65 changes the waveform of flushing. However, it is not limited to this. For example, in addition to the

waveform, various setting conditions for flushing such as a number of flushing times, an interval of flushing and a cycle of flushing or the like may be changed, or any one of the foregoing setting conditions may be changed. The change of the various setting conditions, for example, is preferably performed in such a manner that the number of flushing times is increased, the interval of flushing is shortened, and the cycle of the flushing is prolonged because the ink viscosity is lower when the ink temperature is high in comparison with a case of a low temperature. This variable setting may be set by operation from the corrected ink temperature, or each setting may be set based on the correction table.

[0222]

Moreover, in the above-described embodiments 2 to 6, flushing is performed before type-printing; however a similar effect is obtained also by performing flushing after type-printing.

[0223]

Furthermore, regarding prevention of a color mixture after cleaning, and regular printing or printing in bulk when type-printing is performed for a long period of time, a similar effect is also obtained.

[0224]

In this way, in the above-described embodiments 2 to 6, the control of the preparatory ejection is changed independently of the driving signal during regular printing. Thus, the proper preparatory ejection is always feasible irrespective of a change

of the environmental temperature.

[0225]

And, it is needless to say that the control of the driving signal for regular printing may be also performed together with the control of the driving signal for the preparatory ejection as described in the embodiments 2 to 6.

[0226]

Furthermore, the ink-jet recording method as described in the embodiments 1 to 6 may be provided in a form stored in various recording media such as a floppy disk and a CD-ROM, as a program for correcting the driving signal of the ink-jet recording apparatus, or a program for changing control of the preparatory ejection operation, and may be executed by updating a control program stored in a storage device of a host computer or in a rewritable memory of a printer from the recording media, or by installing in a RAM and the like.

[0227]

[Effect of the Invention]

As described above, according to the present invention, the driving signal correcting means is provided for correcting the driving signal to be generated by the driving signal generating means, based on the temperature change amount obtained by the temperature change amount obtaining means and the ink reservation amount obtained by the ink reservation amount obtaining means. Accordingly, when the environmental temperature is sharply changed in a short period of time and

even if the temperature of the ink reserved in the ink reservoir portion is changed more slowly than the environmental temperature, the ink temperature at that moment can be obtained based on the temperature change amount, thus enabling the driving signal to be set as suitable for this ink temperature. In addition, by correcting the setting such as the ejection waveform of the preparatory ejection operation corresponding to this ink temperature, preparatory ejection can be properly performed.

[0228]

For this reason, even when the environmental temperature is changed to a large extent in a short period of time due to an operation of an air conditioner or the like, the ejection amount of ink droplets can be made constant irrespective of the change of the environmental temperature. As a result, the image quality can be stabilized. Moreover, plugging of the nozzle orifice of the recording head, type-printing defects and the like can be prevented by performing the preparatory ejection operation corresponding to the ink temperature in the ink cartridge.

[Brief Description of the Drawings]

[Figure 1]

Fig. 1 is a perspective view explaining a printing mechanism of an ink-jet printer according to the embodiment 1 of the present invention.

[Figure 2]

Fig. 2 is a view showing a mechanical structure of a

recording head according to the embodiment 1 of the present invention.

[Figure 3]

Fig. 3 is a block diagram explaining an electrical constitution of the ink-jet printer according to the embodiment 1 of the present invention.

[Figure 4]

Fig. 4 is a block diagram explaining a constitution of a control section according to the embodiment 1 of the present invention.

[Figure 5]

Fig. 5 is a flowchart explaining an operation of the ink-jet printer according to the embodiment 1 of the present invention.

[Figure 6]

Fig. 6 is a graph illustrating relations between leaving time and ink temperatures in ink cartridges according to the embodiment 1 of the present invention.

[Figure 7]

Figs. 7 (a) to 7 (c) are views explaining a driving pulse which constitutes a driving signal according to the embodiment 1 of the present invention: Fig. 7 (a) shows a standard driving pulse; Fig. 7 (b) a driving pulse having a driving voltage set high; and Fig. 7 (c) a driving pulse having a driving voltage set low, respectively.

[Figure 8]

Figs. 8 (a) to 8 (c) are views explaining correction of the driving signal according to the embodiment 1 of the present

invention: Fig. 8 (a) shows a driving pulse having an intermediate voltage set low; Fig. 8 (b) a driving pulse having a voltage slope of an expansion element set gentle; and Fig. 8 (c) a driving pulse having a first holding element set long, respectively.

[Figure 9]

Fig. 9 (a) to 9 (c) are views explaining correction of the driving signal according to the embodiment 1 of the present invention: Fig. 9 (a) shows a driving pulse having the intermediate voltage set high; Fig. 9 (b) a driving pulse having the voltage slope of the expansion element set large; and Fig. 9 (c) a driving pulse having the first holding element set short, respectively.

[Figure 10]

Fig. 10 is a flowchart explaining an operation of an ink-jet printer of another example according to the embodiment 1 of the present invention.

[Figure 11]

Fig. 11 is a flowchart explaining an operation of an ink-jet printer of still another example according to the embodiment 1 of the present invention.

[Figure 12]

Fig. 12 is a block diagram explaining a constitution of a control section according to the embodiment 2 of the present invention.

[Figure 13]

Fig. 13 is a flowchart explaining an operation of an ink-jet printer according to the embodiment 2 of the present invention.

[Figure 14]

Fig. 14 is a flowchart explaining an operation of an ink-jet printer according to the embodiment 3 of the present invention.

[Figure 15]

Fig. 15 is a block diagram explaining a constitution of a control section according to the embodiment 4 of the present invention.

[Figure 16]

Fig. 16 is a flowchart explaining an operation of an ink-jet printer according to the embodiment 4 of the present invention.

[Figure 17]

Fig. 17 is a flowchart explaining an operation of an ink-jet printer according to the embodiment 5 of the present invention.

[Figure 18]

Fig. 18 is a flowchart explaining an operation of an ink-jet printer according to the embodiment 6 of the present invention.

[Explanation of Referenced Numerals]

1 ink-jet printer

2 carriage

3 guide member

4 driving pulley

5 free rotating pulley

6 timing belt

7 pulse motor

8 recording paper

11 recording head

12 ink cartridge

13 nozzle orifice

14 temperature sensor

15 cap member

16 wiper member

17 platen

21 ink chamber

22 nozzle plate

23 piezoelectric element

24 pressure chamber

25 ink supply orifice

26 supplying side communicating bore

27 first nozzle communicating bore

28 second nozzle communicating bore

31 printer controller

32 print engine

33 sensor interface

34 external interface

35 RAM

36 backup memory

37 ROM

38 control section

39 oscillation circuit

40 driving signal generating circuit

41 power source generating section

42 internal interface

43 recording medium

45 A/D converter

46 storing section

47 power source supply section

50 paper feeding motor

51 electric driving system of recording head

52 shift register circuit

53 latching circuit

54 level shifter circuit

55 switching circuit

61 ink reservation amount obtaining means

62 temperature change amount obtaining means

63 driving signal correcting means

64 preparatory ejection controlling means

65 changing means

66 data controlling means

[Document name] Abstract

[Abstract]

[Subject]

To allow recording of a stable image quality by virtue of capability of having an ejection amount of ink droplets constant in spite of occurrence of a temperature change at a place where a recording apparatus is utilized.

[Means for solution]

A temperature change amount of a recording head is obtained based on head temperature information stored in a backup memory (S17), and, an ink reservation amount in an ink cartridge is obtained (S16). A driving signal is corrected based on these temperature change and ink reservation amounts (S17).

[Selected figure] Fig. 5

FIG. 3

7 PULSE MOTOR

14 TEMPERATURE SENSOR

23 PIEZOELECTRIC ELEMENT

35 RECEIVING BUFFER, INTERMEDIATE BUFFER, OUTPUT BUFFER

36 BACKUP MEMORY

38 CONTROL SECTION

39 OSCILLATION CIRCUIT

40 DRIVING SIGNAL GENERATING CIRCUIT

41 POWER SOURCE GENERATING SECTION

43 RECORDING MEDIUM

45 A/D CONVERTER

46 STORING SECTION

47 POWER SOURCE SUPPLY SECTION

50 PAPER FEEDING MOTOR

52 SHIFT REGISTER CIRCUIT

53 LATCHING CIRCUIT

54 LEVEL SHIFTER CIRCUIT

55 SWITCHING CIRCUIT

POWER SOURCE

FIG. 4

38 CONTROL SECTION

61 INK RESERVATION AMOUNT OBTAINING MEANS

62 TEMPERATURE CHANGE AMOUNT OBTAINING MEANS

63 DRIVING SIGNAL CORRECTING MEANS

FIG. 5

S10 TURN ON POWER SOURCE

S11 DETECT HEAD TEMPERATURE

S12 STORE DATA

S13 IS PRINTING SIGNAL PRESENT?

S14 DETECT HEAD TEMPERATURE

S15 STORE DATA

S16 DETECT INK CARTRIDGE RESIDUAL AMOUNT

S17 SET DRIVING WAVEFORM BY OPERATION

S18 TYPE-PRINT FOR ONE PATH

S19 IS PRINTING SIGNAL PRESENT?

FIG. 6

INK TEMPERATURE

TIME

RELATION BETWEEN TIME AND INK TEMPERATURE

(TEMPERATURE CHANGE $\Delta T=20°C$)

FIG. 10

POWER SOURCE OFF

S10 TURN ON POWER SOURCE

S21 HAS SPECIFIED TIME PASSED SINCE POWER SOURCE OFF?

S22 KEEP TEMPERATURE DATA

S23 DISCARD TEMPERATURE DATA

S11 DETECT HEAD TEMPERATURE

S12 STORE DATA

S13 IS PRINTING SIGNAL PRESENT?

S14 DETECT HEAD TEMPERATURE

S15 STORE DATA

S16 DETECT INK CARTRIDGE RESIDUAL AMOUNT

S17 SET DRIVING WAVEFORM BY OPERATION

S18 TYPE-PRINT FOR ONE PATH

S19 IS PRINTING SIGNAL PRESENT?

FIG. 11

S30 TURN ON POWER SOURCE

S31 STANDBY

S32 INPUT PRINTING SIGNAL

S33 DETECT HEAD TEMPERATURE

S34 STORE DATA

S35 DETECT INK CARTRIDGE RESIDUAL AMOUNT

S36 SET DRIVING WAVEFORM BY OPERATION

S37 TYPE-PRINT FOR ONE PATH

S38 IS PRINTING SIGNAL PRESENT?

FIG. 12

38 CONTROL SECTION

61 INK RESERVATION AMOUNT OBTAINING MEANS

62 TEMPERATURE CHANGE AMOUNT OBTAINING MEANS

64 PREPARATORY EJECTION CONTROLLING MEANS

65 CHANGING MEANS

FIG. 13

S40 TURN ON POWER SOURCE

S41 STANDBY

S42 IS TYPE-PRINTING SIGNAL PRESENT?

S43 DETECT HEAD TEMPERATURE

S44 STORE DATA

S45 DETECT INK CARTRIDGE RESIDUAL AMOUNT

S46 SET FLUSHING WAVEFORM BY OPERATION

S47 FLUSHING

S48 TYPE-PRINT FOR ONE PATH

S49 IS TYPE-PRINTING SIGNAL PRESENT?

FIG. 14

S40 TURN ON POWER SOURCE

S53 DETECT HEAD TEMPERATURE

S54 STORE DATA

S42 IS TYPE-PRINTING SIGNAL PRESENT?

S43 DETECT HEAD TEMPERATURE

S44 STORE DATA

S45 DETECT INK CARTRIDGE RESIDUAL AMOUNT

S46 SET FLUSHING WAVEFORM BY OPERATION

S47 FLUSHING

S48 TYPE-PRINT FOR ONE PATH

S49 IS TYPE-PRINTING SIGNAL PRESENT?

FIG. 15

38 CONTROL SECTION

61 INK RESERVATION AMOUNT OBTAINING MEANS

62 TEMPERATURE CHANGE AMOUNT OBTAINING MEANS

64 PREPARATORY EJECTION CONTROLLING MEANS

65 CHANGING MEANS

66 DATA CONTROLLING MEANS

FIG. 16

TURN OFF POWER SOURCE

S40 TURN ON POWER SOURCE

S50 HAS SPECIFIED TIME OR LONGER PASSED SINCE POWER SOURCE OFF?

S51 DISCARD TEMPERATURE DATA

S52 KEEP TEMPERATURE DATA

S53 DETECT HEAD TEMPERATURE

S54 STORE DATA

S42 IS TYPE-PRINTING SIGNAL PRESENT?

S43 DETECT HEAD TEMPERATURE

S44 STORE DATA

S45 DETECT INK CARTRIDGE RESIDUAL AMOUNT

S46 SET FLUSHING WAVEFORM BY OPERATION

S47 FLUSHING

S48 TYPE-PRINT FOR ONE PATH

S49 IS TYPE-PRINTING SIGNAL PRESENT?

FIG. 17

S40 TURN ON POWER SOURCE

S53 DETECT HEAD TEMPERATURE

S54 STORE DATA

S42 IS TYPE-PRINTING SIGNAL PRESENT?

S60 HAS SPECIFIED TIME OR LONGER PASSED SINCE THE LAST FLUSHING?

S43 DETECT HEAD TEMPERATURE

S44 STORE DATA

S45 DETECT INK CARTRIDGE RESIDUAL AMOUNT

S46 SET FLUSHING WAVEFORM BY OPERATION

S47 FLUSHING

S48 TYPE-PRINT FOR ONE PATH

S49 IS TYPE-PRINTING SIGNAL PRESENT?

FIG. 18

S40 TURN ON POWER SOURCE

S53 DETECT HEAD TEMPERATURE

S54 STORE DATA

S42 IS TYPE-PRINTING SIGNAL PRESENT?

S61 HAS SPECIFIED TIME OR LONGER PASSED SINCE THE LAST FLUSHING?

S43 DETECT HEAD TEMPERATURE

S44 STORE DATA

S45 DETECT INK CARTRIDGE RESIDUAL AMOUNT

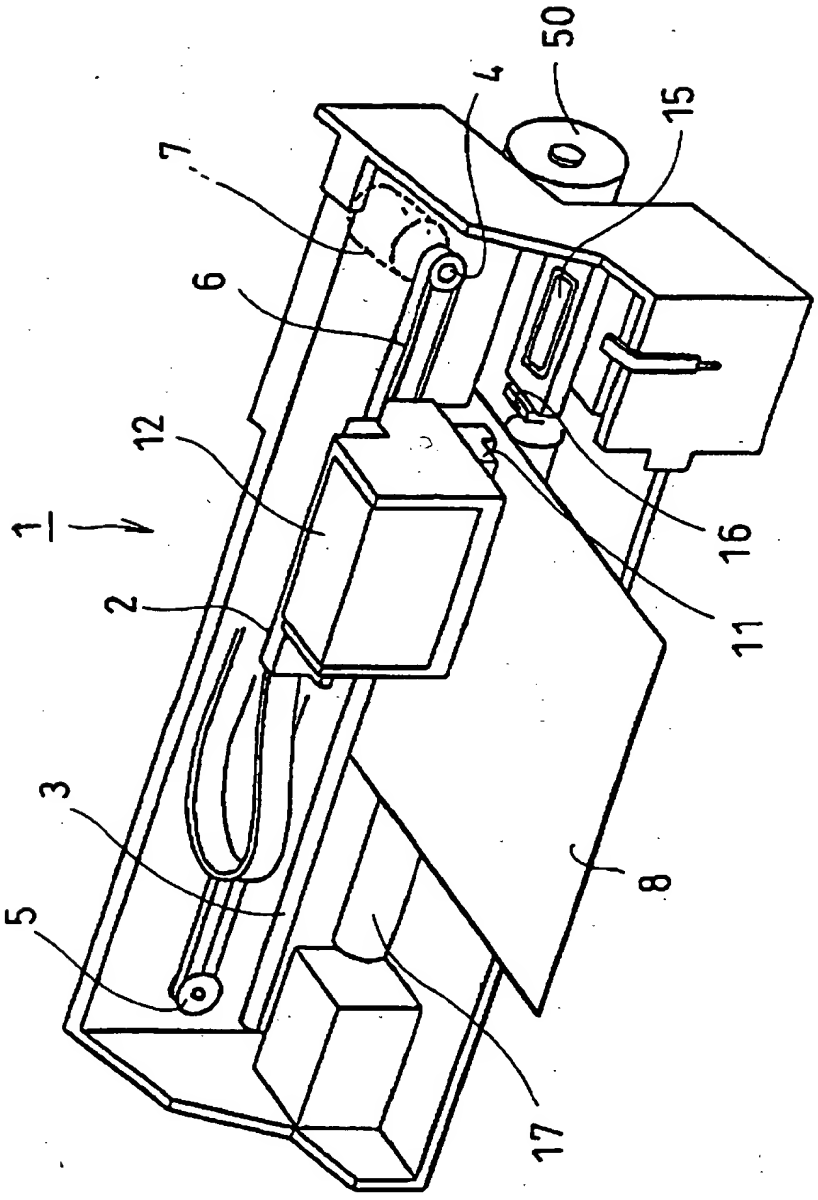
S46 SET FLUSHING WAVEFORM BY OPERATION

S47 FLUSHING

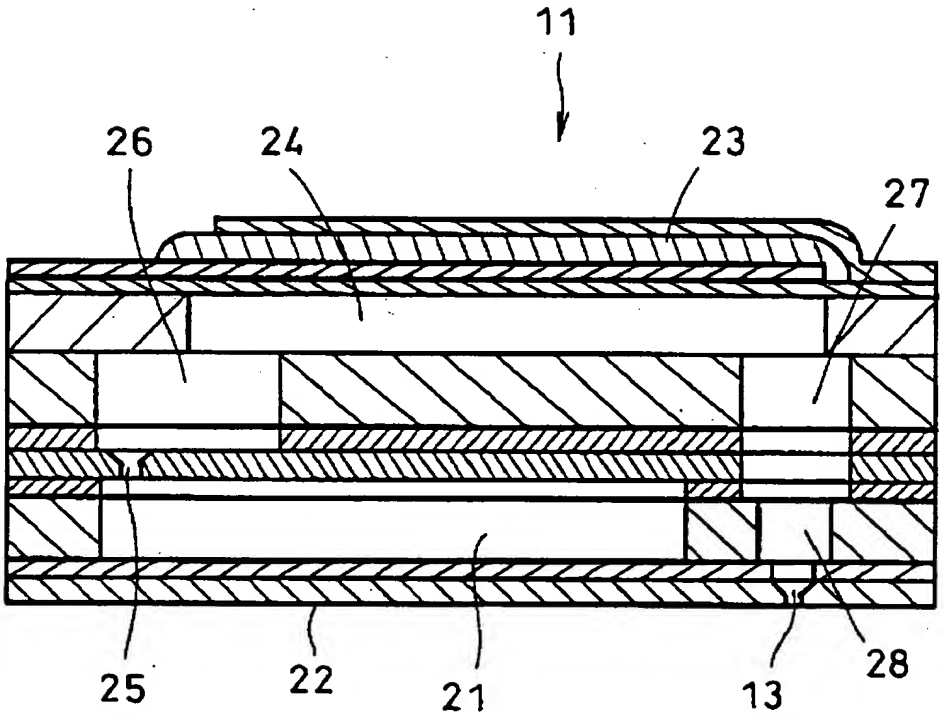
S48 TYPE-PRINT FOR ONE PATH

S49 IS TYPE-PRINTING SIGNAL PRESENT?

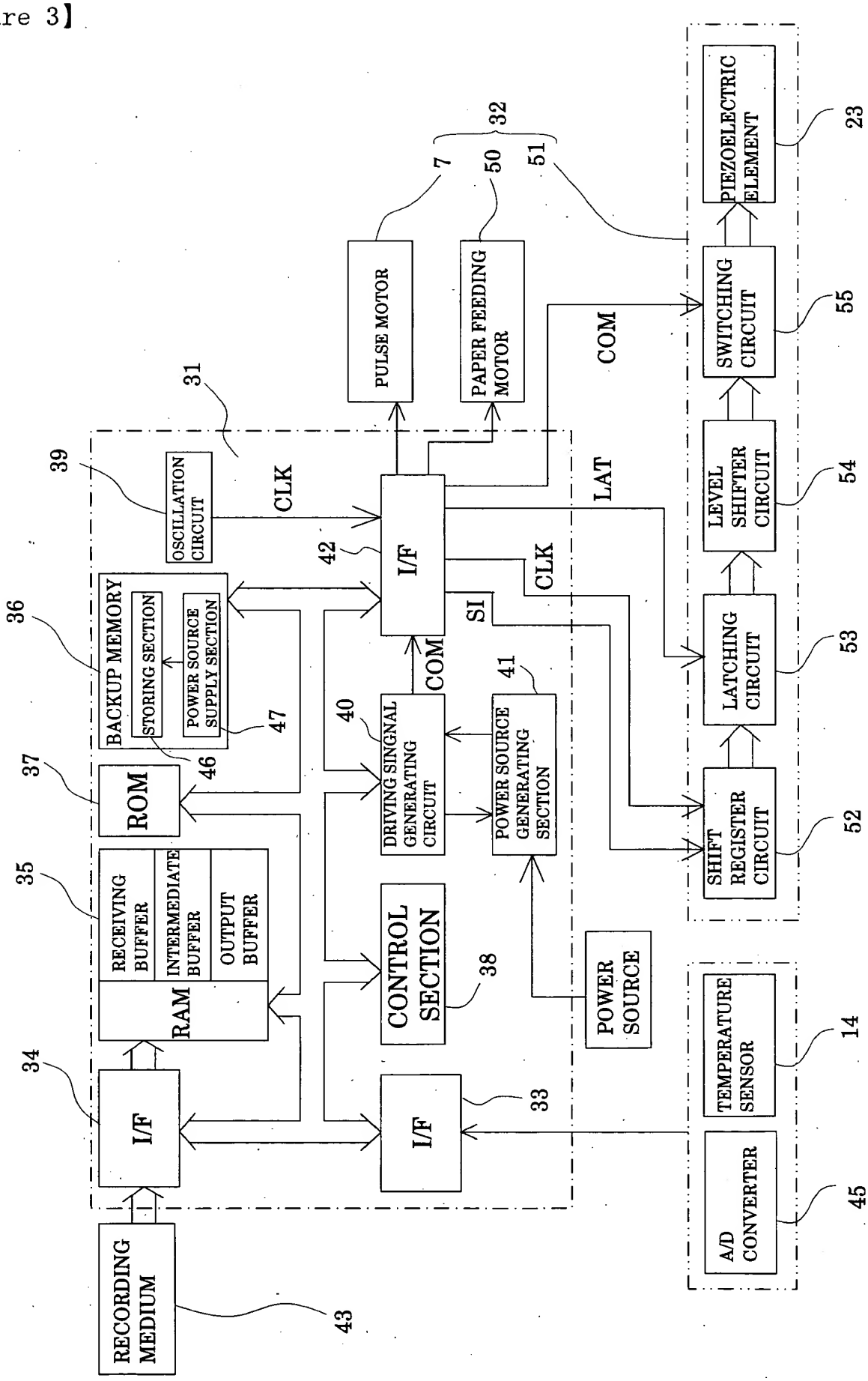
【Document】 Drawings
【Figure 1】



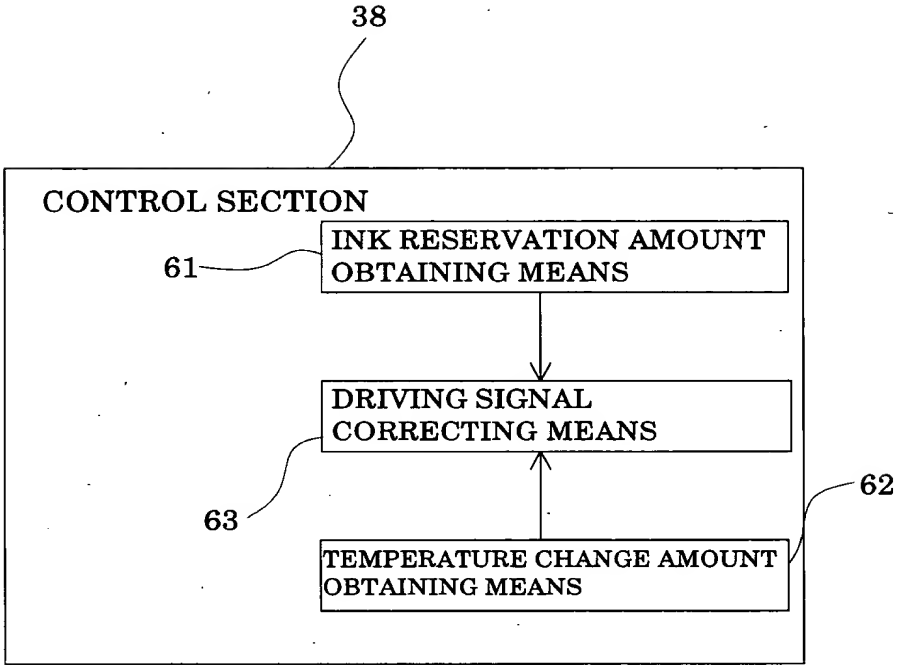
【Figure 2】



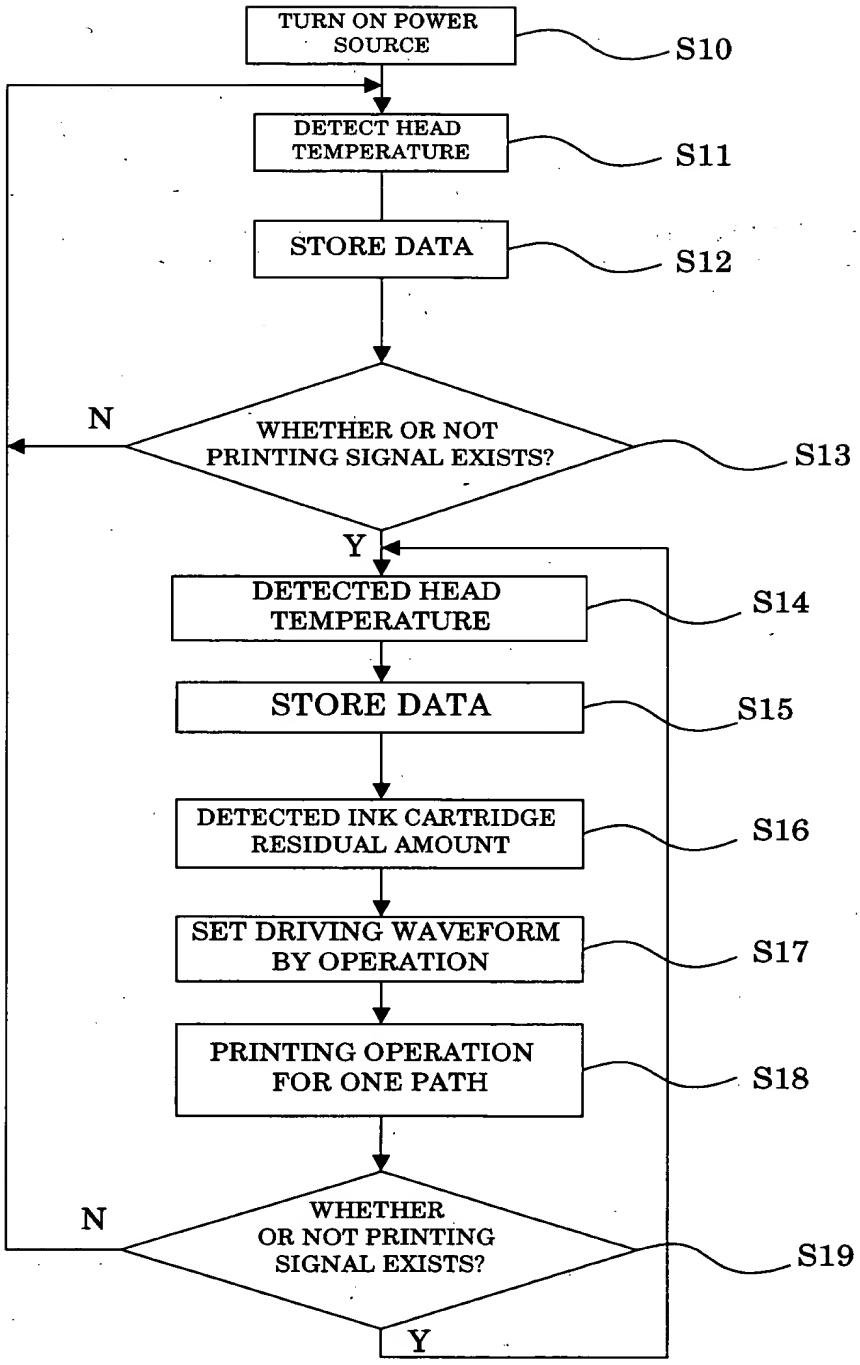
【Figure 3】


RECORDING MEDIUM
43
I/F
34
RAM
RECEIVING BUFFER
INTERMEDIATE BUFFER
OUTPUT BUFFER
35
ROM
37
BACKUP MEMORY
STORING SECTION
POWER SOURCE SUPPLY SECTION
36
46
47
OSCILLATION CIRCUIT
39
31
CLK
I/F
42
CONTROL SECTION
38
I/F
33
DRIVING SINGNAL GENERATING CIRCUIT
40
POWER SOURCE GENERATING SECTION
41
COM
SI
CLK
LAT
POWER SOURCE
PULSE MOTOR
7
PAPER FEEDING MOTOR
50
51
32
COM
SHIFT REGISTER CIRCUIT
52
LATCHING CIRCUIT
53
LEVEL SHIFTER CIRCUIT
54
SWITCHING CIRCUIT
55
PIEZOELECTRIC ELEMENT
23
TEMPERATURE SENSOR
14
A/D CONVERTER
45

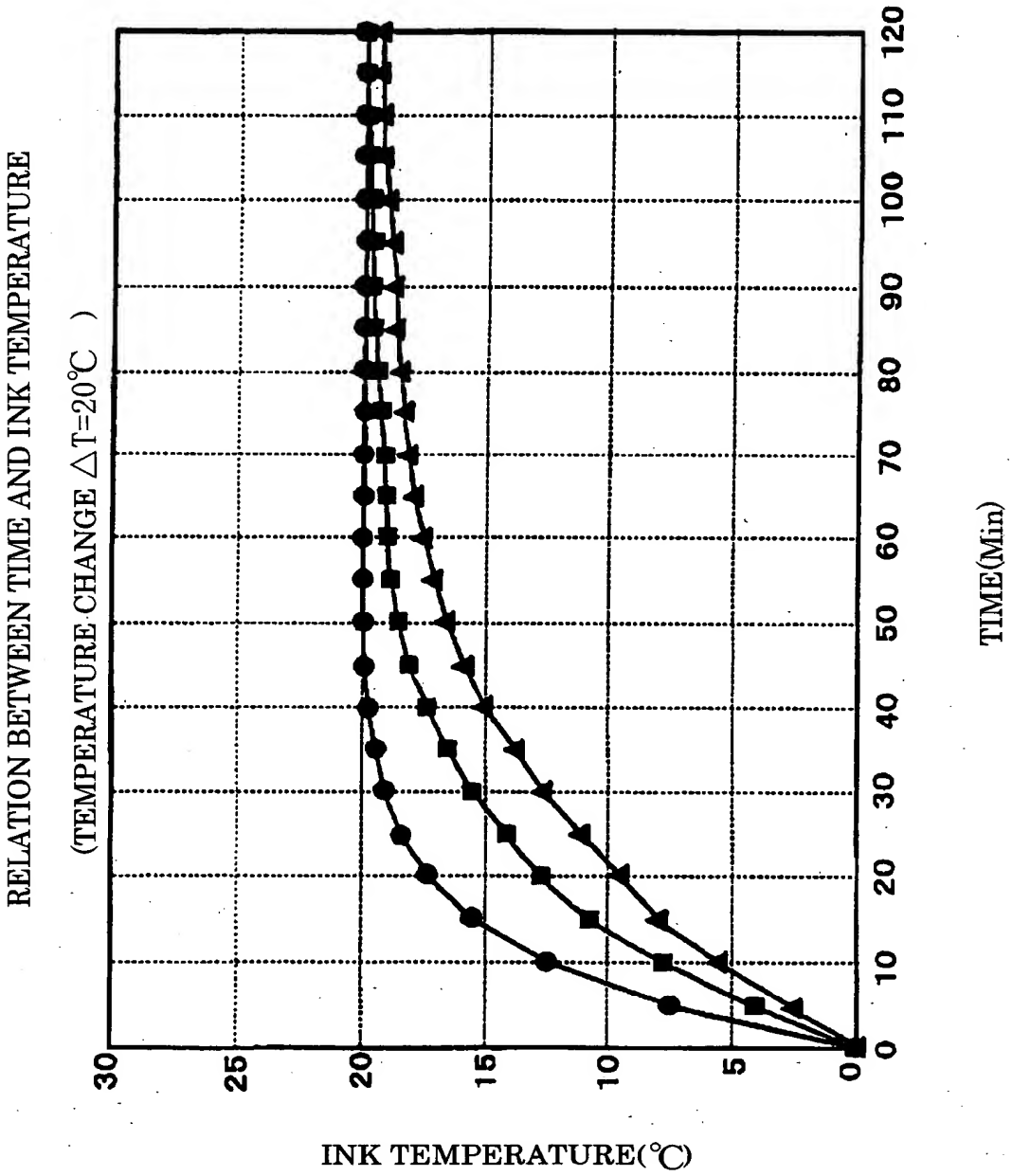
【Figure 4】


38
CONTROL SECTION
INK RESERVATION AMOUNT OBTAINING MEANS
61
DRIVING SIGNAL CORRECTING MEANS
63
62
TEMPERATURE CHANGE AMOUNT OBTAINING MEANS

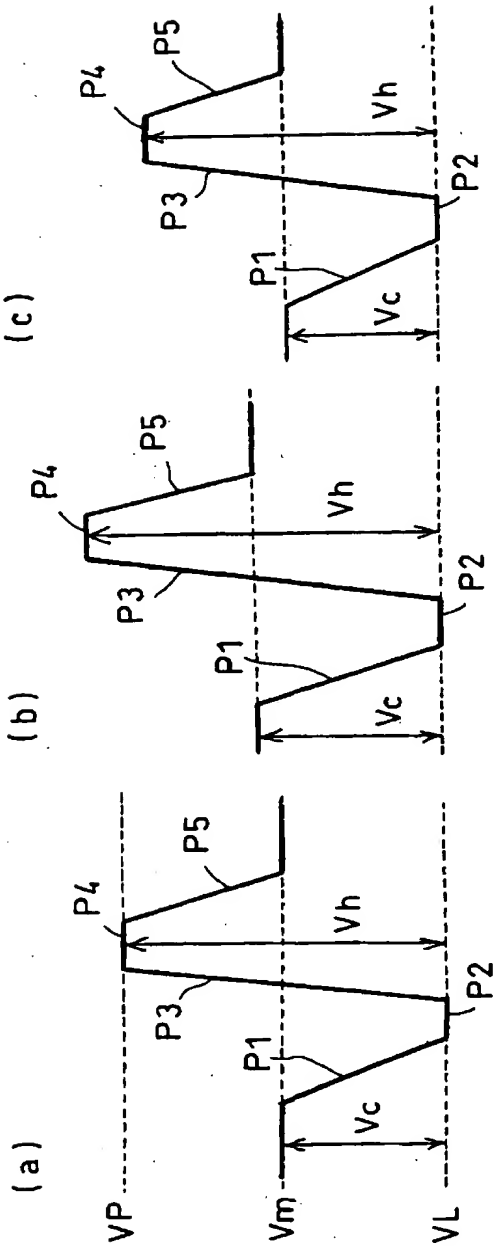
【Figure 5】


TURN ON POWER SOURCE
S10
DETECT HEAD TEMPERATURE
S11
STORE DATA
S12
N
WHETHER OR NOT PRINTING SIGNAL EXISTS?
S13
Y
DETECTED HEAD TEMPERATURE
S14
STORE DATA
S15
DETECTED INK CARTRIDGE RESIDUAL AMOUNT
S16
SET DRIVING WAVEFORM BY OPERATION
S17
PRINTING OPERATION FOR ONE PATH
S18
N
WHETHER OR NOT PRINTING SIGNAL EXISTS?
S19
Y

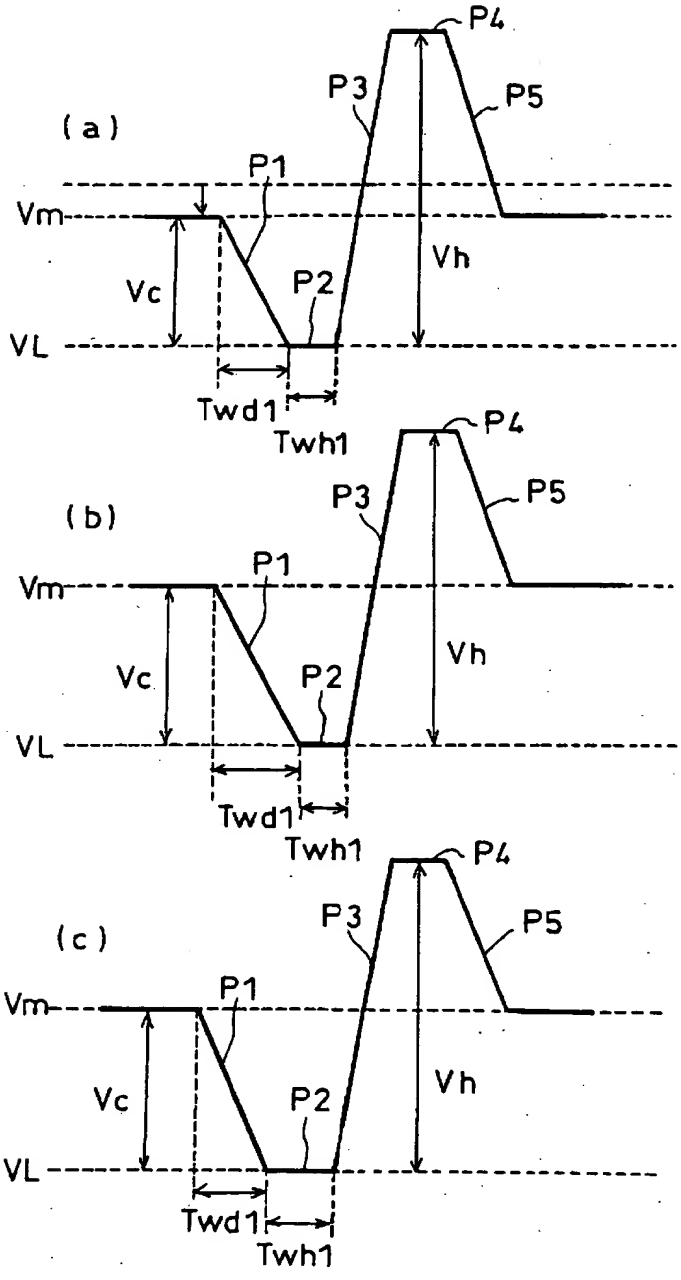
【Figure 6】


RELATION BETWEEN TIME AND INK TEMPERATURE
(TEMPERATURE CHANGE △T=20℃)
INK TEMPERATURE(℃)
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
110
120
TIME(Min)

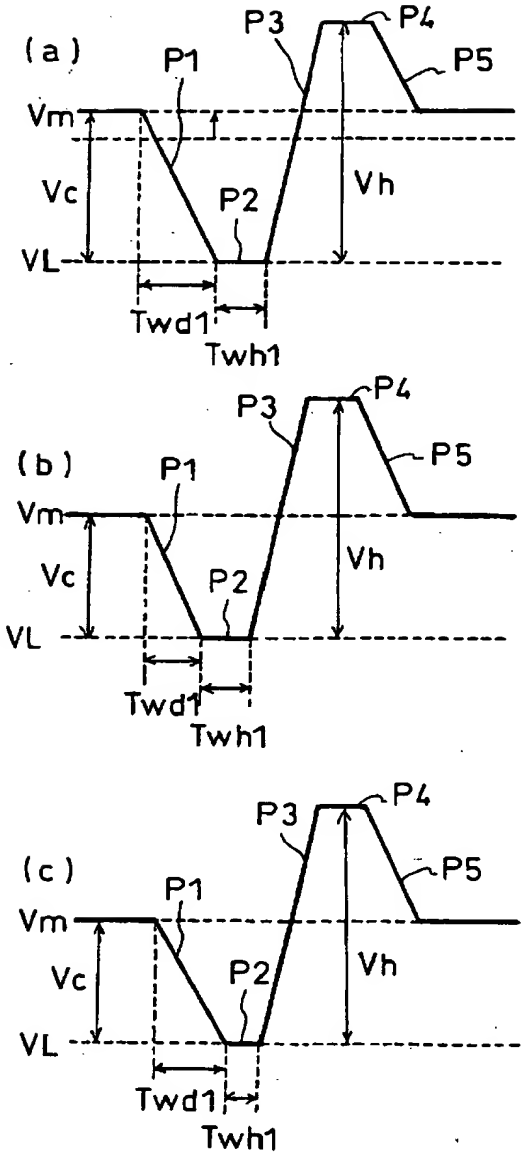
【Figure 7】



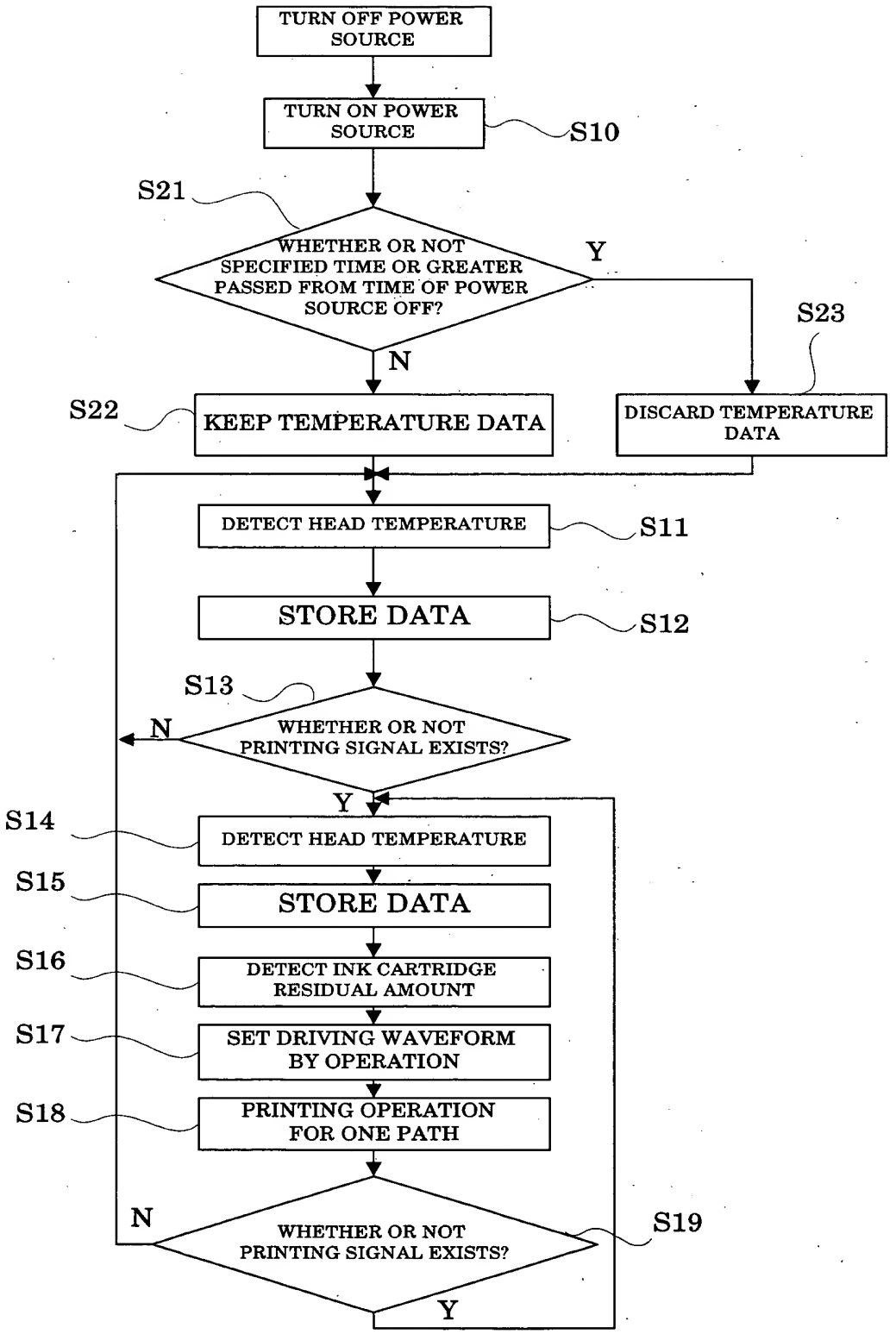
【Figure 8】


(a)
P1
P2
P3
P4
P5
Vm
Vc
VL
Vh
Twd1
Twh1
(b)
P1
P2
P3
P4
P5
Vm
Vc
VL
Vh
Twd1
Twh1
(c)
P1
P2
P3
P4
P5
Vm
Vc
VL
Vh
Twd1
Twh1

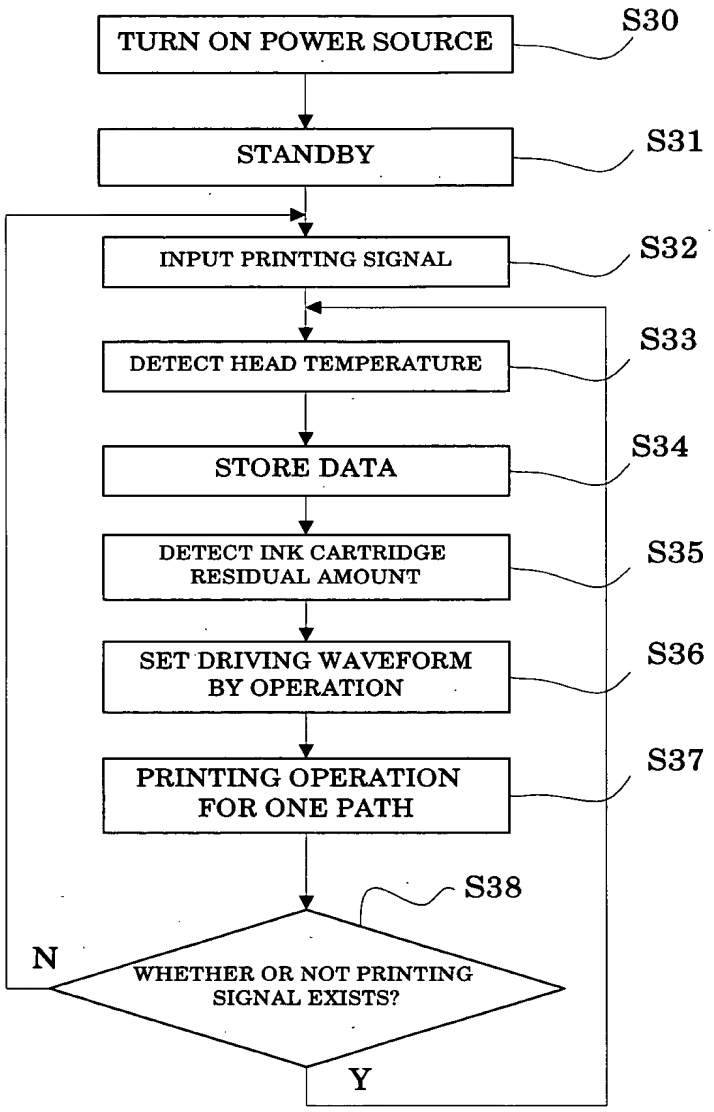
【Figure 9】


(a)
P1
P2
P3
P4
P5
Vm
Vc
VL
Vh
Twd1
Twh1
(b)
P1
P2
P3
P4
P5
Vm
Vc
VL
Vh
Twd1
Twh1
(c)
P1
P2
P3
P4
P5
Vm
Vc
VL
Vh
Twd1
Twh1

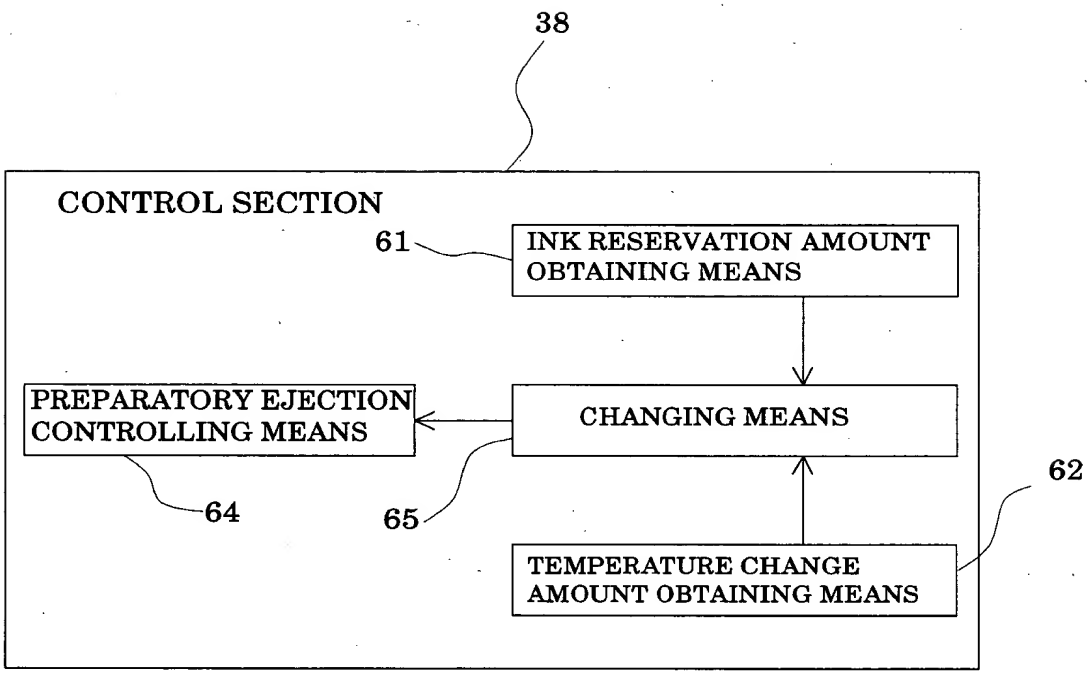
【figure 10】


TURN OFF POWER SOURCE
TURN ON POWER SOURCE
S10
S21
WHETHER OR NOT SPECIFIED TIME OR GREATER PASSED FROM TIME OF POWER SOURCE OFF?
Y
N
S23
S22
KEEP TEMPERATURE DATA
DISCARD TEMPERATURE DATA
DETECT HEAD TEMPERATURE
S11
STORE DATA
S12
S13
N
WHETHER OR NOT PRINTING SIGNAL EXISTS?
Y
S14
DETECT HEAD TEMPERATURE
S15
STORE DATA
S16
DETECT INK CARTRIDGE RESIDUAL AMOUNT
S17
SET DRIVING WAVEFORM BY OPERATION
S18
PRINTING OPERATION FOR ONE PATH
N
WHETHER OR NOT PRINTING SIGNAL EXISTS?
S19
Y

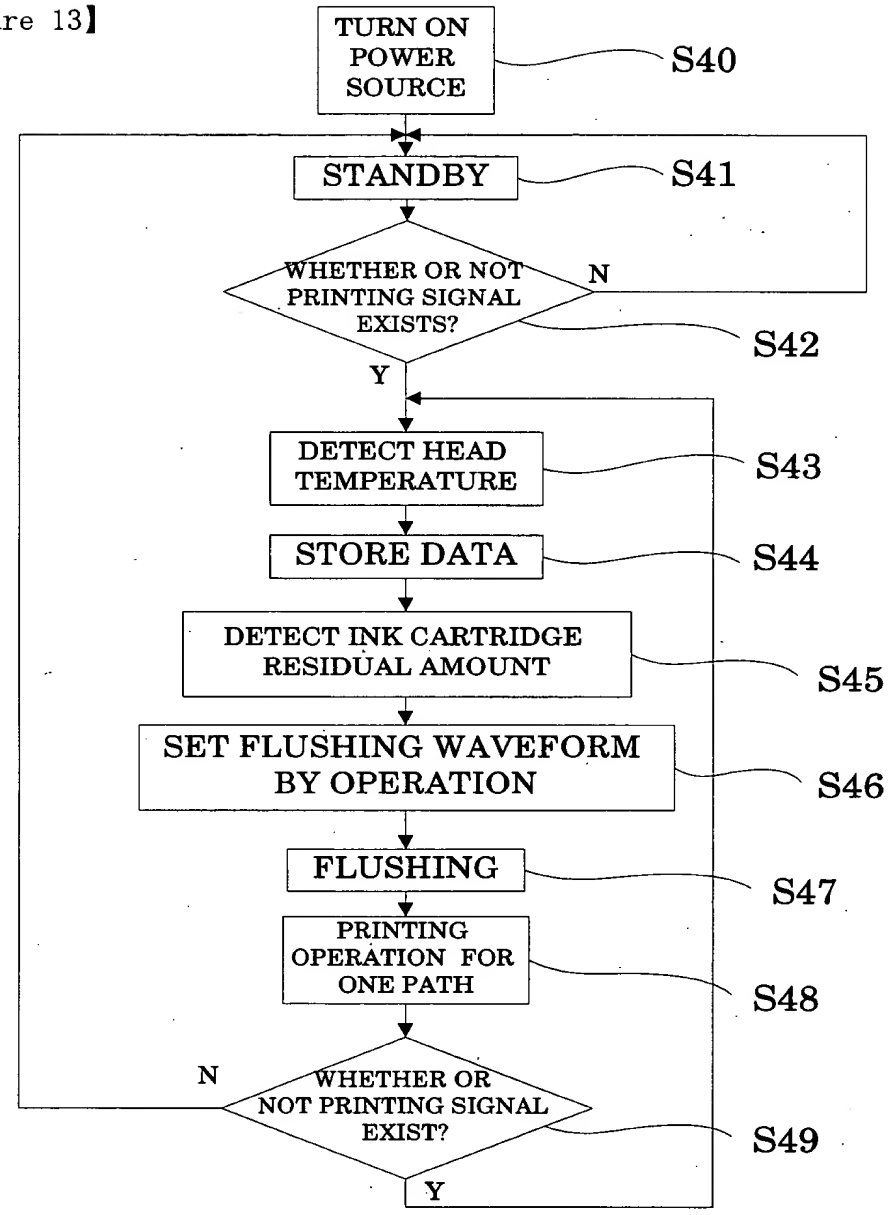
【Figure 11】


TURN ON POWER SOURCE
S30
STANDBY
S31
INPUT PRINTING SIGNAL
S32
DETECT HEAD TEMPERATURE
S33
STORE DATA
S34
DETECT INK CARTRIDGE RESIDUAL AMOUNT
S35
SET DRIVING WAVEFORM BY OPERATION
S36
PRINTING OPERATION FOR ONE PATH
S37
S38
WHETHER OR NOT PRINTING SIGNAL EXISTS?
N
Y

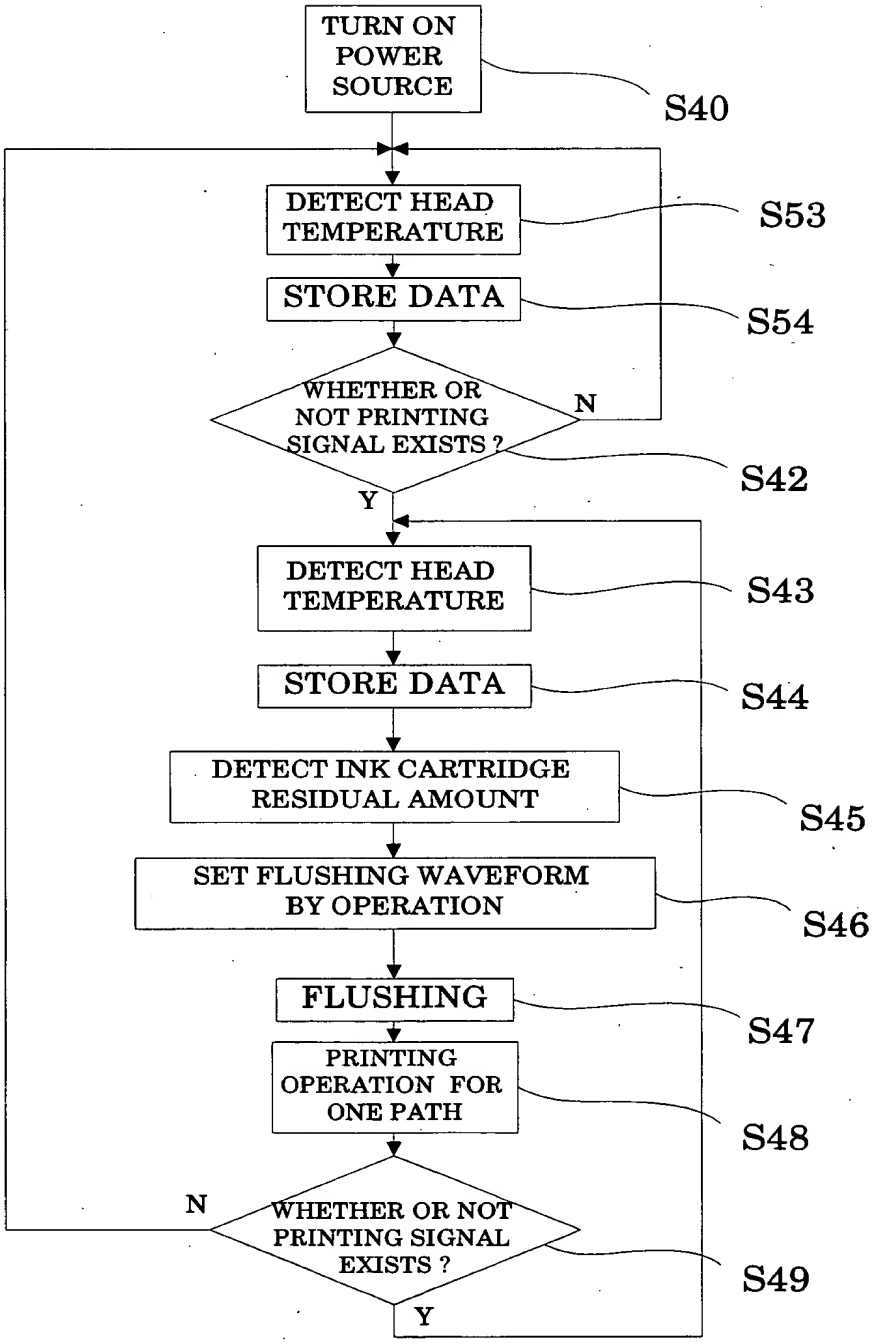
【Figure 12】


38
CONTROL SECTION
61
INK RESERVATION AMOUNT OBTAINING MEANS
CHANGING MEANS
PREPARATORY EJECTION CONTROLLING MEANS
64
65
62
TEMPERATURE CHANGE AMOUNT OBTAINING MEANS

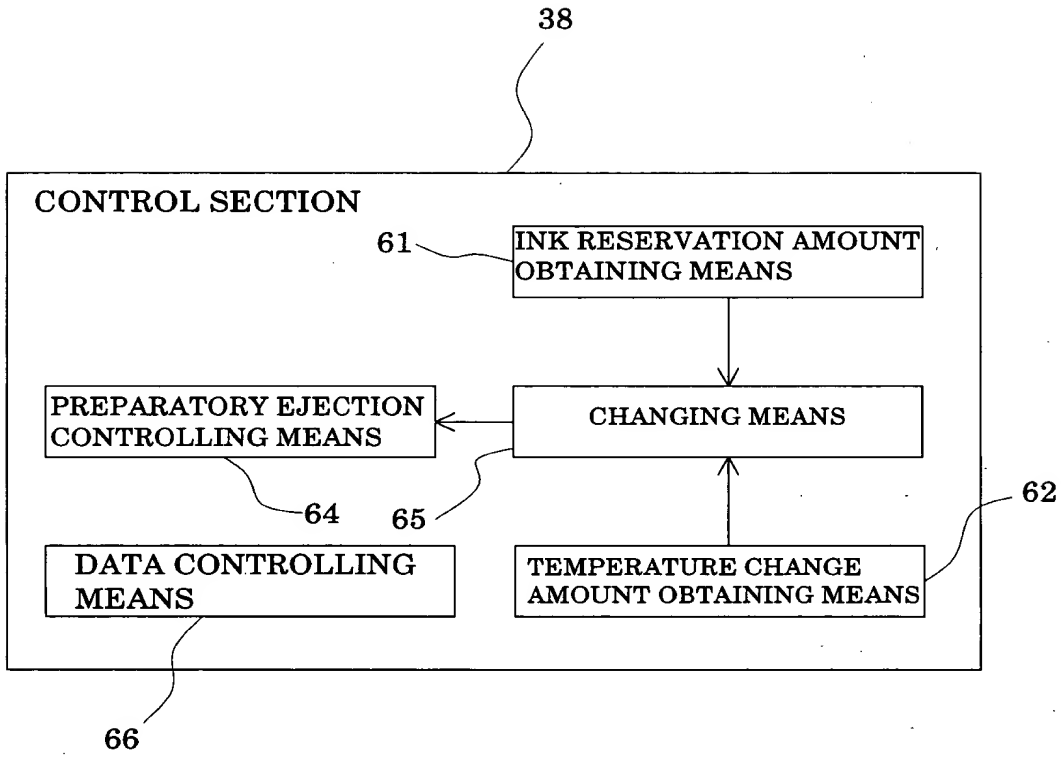
【Figure 13】


TURN ON POWER SOURCE
S40
STANDBY
S41
WHETHER OR NOT PRINTING SIGNAL EXISTS?
N
S42
Y
DETECT HEAD TEMPERATURE
S43
STORE DATA
S44
DETECT INK CARTRIDGE RESIDUAL AMOUNT
S45
SET FLUSHING WAVEFORM BY OPERATION
S46
FLUSHING
S47
PRINTING OPERATION FOR ONE PATH
S48
N
WHETHER OR NOT PRINTING SIGNAL EXIST?
S49
Y

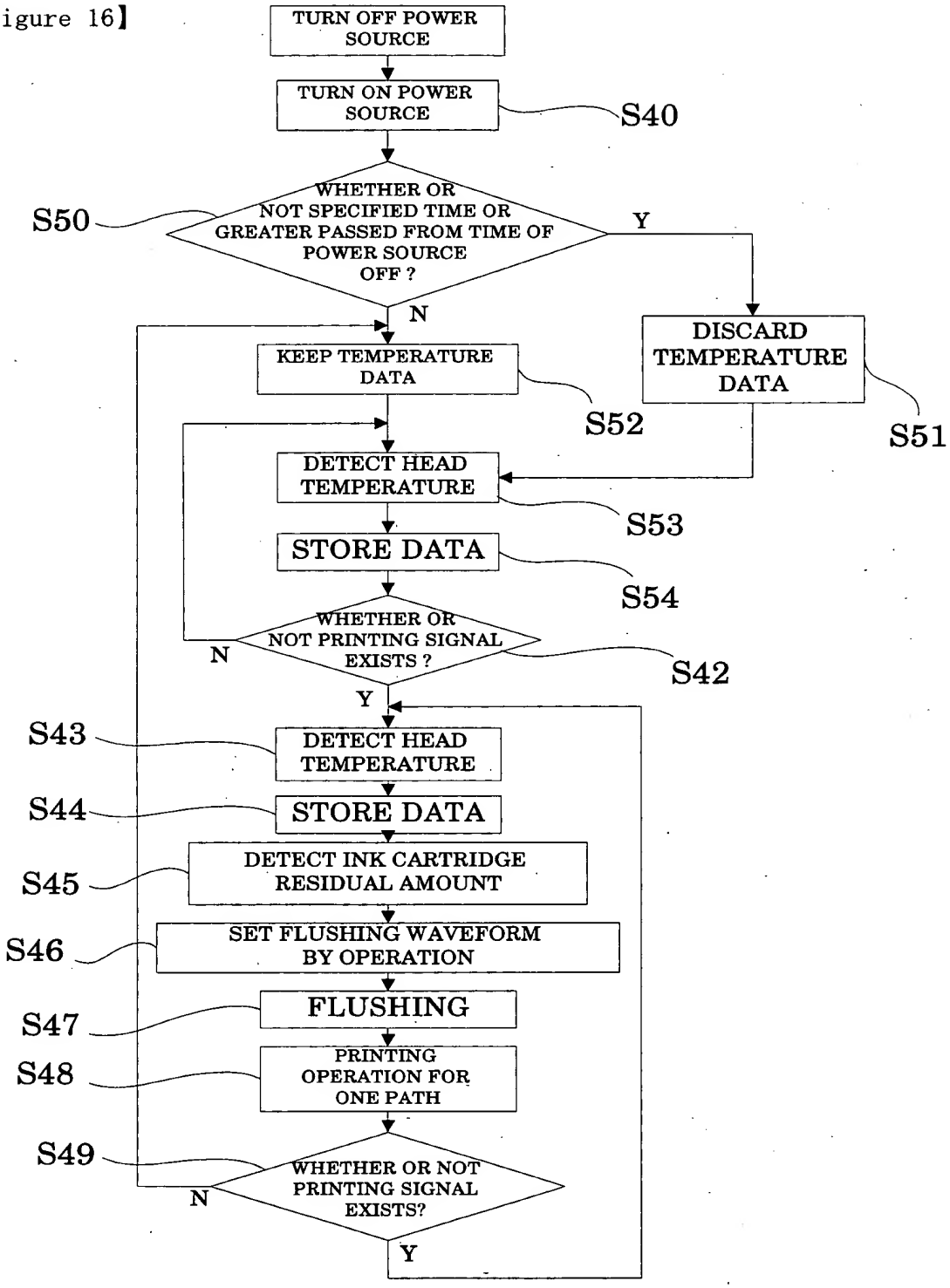
【Figure 14】


TURN ON POWER SOURCE
S40
DETECT HEAD TEMPERATURE
S53
STORE DATA
S54
WHETHER OR NOT PRINTING SIGNAL EXISTS ?
N
S42
Y
DETECT HEAD TEMPERATURE
S43
STORE DATA
S44
DETECT INK CARTRIDGE RESIDUAL AMOUNT
S45
SET FLUSHING WAVEFORM BY OPERATION
S46
FLUSHING
S47
PRINTING OPERATION FOR ONE PATH
S48
N
WHETHER OR NOT PRINTING SIGNAL EXISTS ?
S49
Y

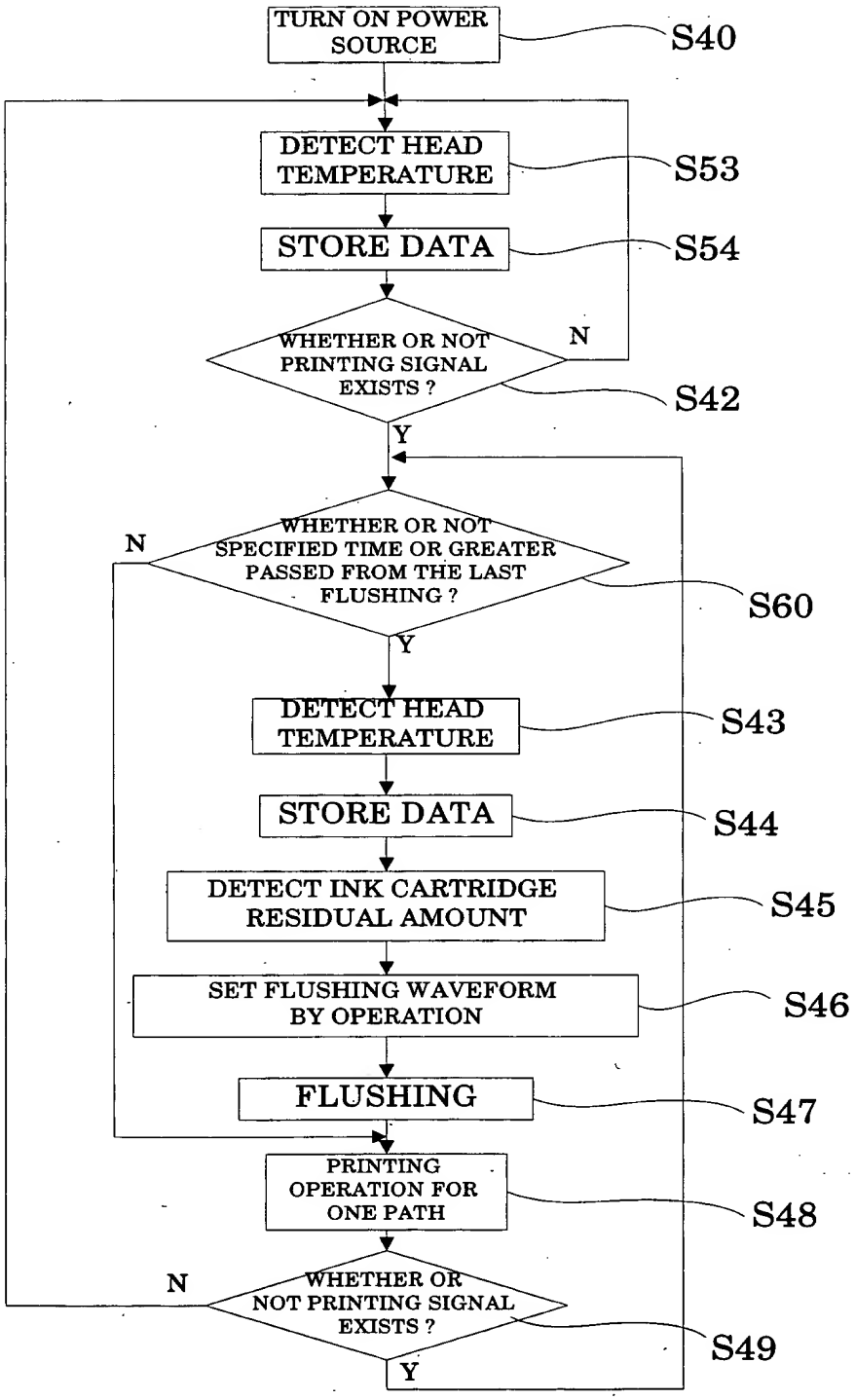
【Figure 15】


38
CONTROL SECTION
61
INK RESERVATION AMOUNT OBTAINING MEANS
PREPARATORY EJECTION CONTROLLING MEANS
CHANGING MEANS
64
65
62
DATA CONTROLLING MEANS
TEMPERATURE CHANGE AMOUNT OBTAINING MEANS
66

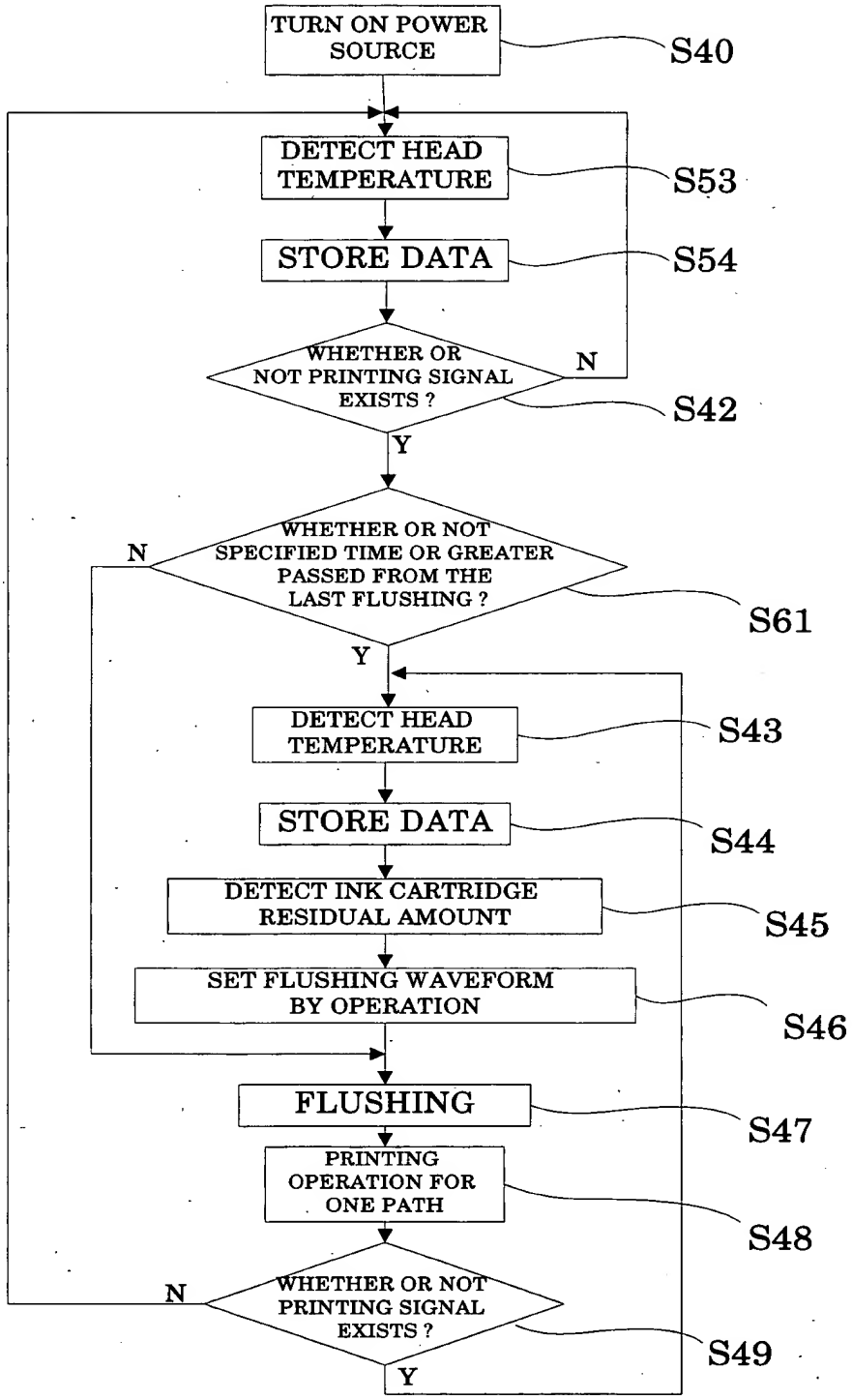
【Figure 16】


TURN OFF POWER SOURCE
TURN ON POWER SOURCE
S40
S50
WHETHER OR NOT SPECIFIED TIME OR GREATER PASSED FROM TIME OF POWER SOURCE OFF ?
Y
N
DISCARD TEMPERATURE DATA
S51
KEEP TEMPERATURE DATA
S52
DETECT HEAD TEMPERATURE
S53
STORE DATA
S54
WHETHER OR NOT PRINTING SIGNAL EXISTS ?
S42
N
Y
S43
DETECT HEAD TEMPERATURE
S44
STORE DATA
S45
DETECT INK CARTRIDGE RESIDUAL AMOUNT
S46
SET FLUSHING WAVEFORM BY OPERATION
S47
FLUSHING
S48
PRINTING OPERATION FOR ONE PATH
S49
WHETHER OR NOT PRINTING SIGNAL EXISTS?
N
Y

【Figure 17】


TURN ON POWER SOURCE
S40
DETECT HEAD TEMPERATURE
S53
STORE DATA
S54
WHETHER OR NOT PRINTING SIGNAL EXISTS ?
N
S42
Y
WHETHER OR NOT SPECIFIED TIME OR GREATER PASSED FROM THE LAST FLUSHING ?
N
S60
Y
DETECT HEAD TEMPERATURE
S43
STORE DATA
S44
DETECT INK CARTRIDGE RESIDUAL AMOUNT
S45
SET FLUSHING WAVEFORM BY OPERATION
S46
FLUSHING
S47
PRINTING OPERATION FOR ONE PATH
S48
WHETHER OR NOT PRINTING SIGNAL EXISTS ?
N
S49
Y

【Figure 18】


TURN ON POWER SOURCE
S40
DETECT HEAD TEMPERATURE
S53
STORE DATA
S54
WHETHER OR NOT PRINTING SIGNAL EXISTS ?
N
S42
Y
WHETHER OR NOT SPECIFIED TIME OR GREATER PASSED FROM THE LAST FLUSHING ?
N
S61
Y
DETECT HEAD TEMPERATURE
S43
STORE DATA
S44
DETECT INK CARTRIDGE RESIDUAL AMOUNT
S45
SET FLUSHING WAVEFORM BY OPERATION
S46
FLUSHING
S47
PRINTING OPERATION FOR ONE PATH
S48
WHETHER OR NOT PRINTING SIGNAL EXISTS ?
N
S49
Y